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Indigo.

By DR F. MOLLWO PERKIN.

ONE of the oldest and most valuable of colouring matters is indigo. Its properties and use were known in India and Egypt many years before the christian era. It is described by Pliny, who says it was used as a paint, and from what he says it would appear that the merchants of his time were not very much better than some in our own days, because the indigo was often adulterated with chalk or the excrements of pigeons, and Pliny gives tests by which the pure product might be known. It was not until the 16th century that indigo was introduced into Europe. When it was first introduced, however, the sellers of indigo encountered great opposition, and it was not until considerably later that its use became at all general.

It was the cultivators of woad who opposed its introduction so violently; they contended that the dye was fugitive, and was also a pernicious and corrosive poison. So great was their influence and opposition

Fig. 1.—Indigofera tinctoria.

Fig. 2.—Isatis tinctoria.

that Henry IV. of France issued an edict in which it was made a capital offence to use or sell this pernicious drug, or devil's food, as it was called. There was also a statute in England which prohibited the use of indigo, and to this day that statute has, I believe, never been repealed. The interesting point about the opposition of the woad cultivators is that woad itself is a variety of indigo, and the blue dye with which the ancient Britons anointed their skin, in place of warmer clothing, was, in fact, indigo blue.

The indigo plant, *Indigofera tinctoria*, is shown in Fig. 1, the woad plant, *Isatis tinctoria*, in Fig. 2. As a matter of fact, woad is, to a certain extent, still grown in Lincolnshire and in the south of France and

Hungary. It is not generally used for dyeing *per se*, but is employed in the preparation of certain indigo vats.

The indigo plant is herbaceous, and grows to a height of from three to four feet, having a single stem about half an inch in diameter. The land on which the plant is grown is ploughed in October or November and sown with the indigo seed at about the end of March or the beginning of April. The plant is of rapid growth, and is cut for the first crop in about the middle of June to the beginning of July—if the weather has been propitious, usually at the earlier date. The indigo plant is cut when it is just mature, as indicated by the opening of the flower buds. After about eight weeks a second crop is obtained, but the yield of indigo is not so good as from the first crop.

Treatment of Plants.

We will not here describe all the different methods which are employed for obtaining the indigo from the plant, but will merely give an idea how the process is, in general, carried out. It must, in the first place, be understood that the indigo does not exist in the free state, *i.e.*, in the form of a blue dye, but is there as a *glucoside*—that is, combined with a kind of sugar called *indiglucin*, and this compound has first to be split up before the indigo can be obtained.

The indigo plants after cutting are tied up into bundles, and the bundles carefully and tightly packed into vats built of brickwork and lined with stone or cement. When the vat is completely filled with the indigo plant, beams of wood are wedged across the bundles and water is run in so as to completely cover the plant. The object of wedging the bundles down is to keep them below the water and to prevent them being forced out when they swell, after the water has been added. In a short time an active fermentation sets in, which generally lasts from 10 to 15 hours according to the temperature of the air and the condition of the plant. As soon as the fermentation becomes tranquil the liquor is run off into the beating vats. At this stage it varies in colour from a pale to a golden yellow—the darker the colour the greater the yield of indigo, but the light-coloured liquor, though yielding less, gives a finer product. In the beating vat the liquor is agitated by means of wooden paddles or shovels, which are worked by hand. (In many factories the beating is now done by machinery.) As the beating is continued the yellow liquor gradually changes from green to blue, and finally solid indigo begins to separate out. After the beating is finished the blue fluid containing the suspended indigo is run into the settling tank, where the indigo slowly falls to the bottom, leaving the clear liquid above. The supernatant liquor is then run off and the mud of indigo pumped up into a caldron and boiled. This boiling serves to prevent a second and destructive fermentation setting in, which would both spoil the quality and the quantity of the indigo; it also serves to wash it and remove impurities. After boiling it is run on to a large filter called the dripping vat, which may be from 20 feet long by 10 feet wide and 3 feet deep, the size, however, varies in different works.

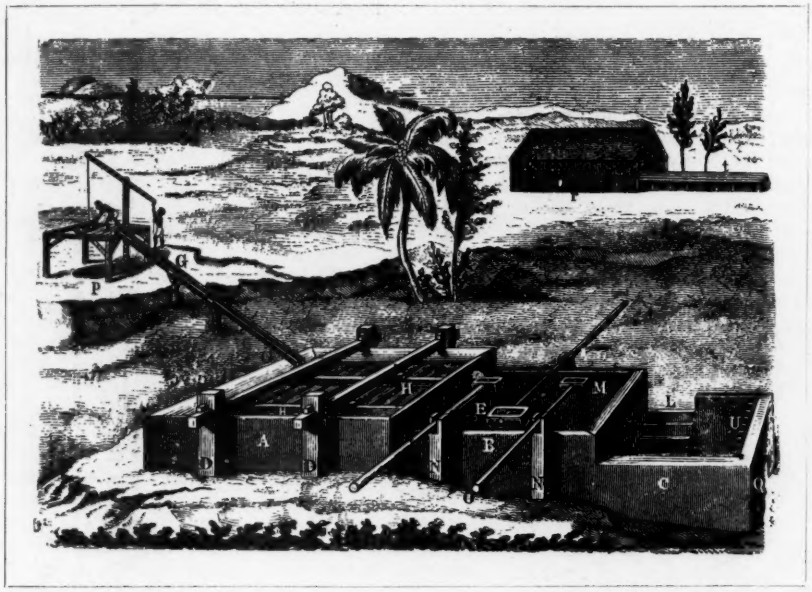

Fig. 3.

After draining for about 24 hours the pasty indigo is placed in perforated cloth-lined wooden boxes and is subjected to a gradually increasing pressure until no more liquid runs out. It is then cut into small blocks with a knife or brass wire, in much the same way that cheese is cut; the blocks being usually about 3 inches square. The cubes of indigo are then placed on a trellised staging covered with matting, which is contained in open sheds and dried by exposure to the air, direct sunlight being carefully excluded. The quantity of indigo obtained from each fermenting vat varies from 30 to 50 lbs.

Fig. 3 shows in a somewhat picturesque manner an indigo factory. A is the fermentation vat with the posts DD to hold the bars HH, which are employed to press down the bundles of the indigo plant. E is the pipe through which the fermented

liquor is run into the beating vat B. The beaters OM are held by the wooden fork N. C is the precipitating tank with the steps L, which are used for entering the vat to clean or empty it. Q is the outlet for the supernatant liquor. P is the well from which the water is obtained with the trough GG leading into the fermenting vat. V is the drying house in which the staging for placing the indigo is shown at t.

It has already been stated that the indigo is not found in the free state in the plant itself, but in the form of a *glucoside* called *indican*, which must be split up in order to obtain the indigo. This spliting up process is supposed to take place during the fermentation, but by the fermentation the indigo blue is not directly formed, a product called indigo white being produced. Now indigo itself is not a soluble substance, but indigo white is, and can be obtained from indigo blue by taking away part of its oxygen. When, then, this solution of indigo white is run into the beating vat and agitated, air becomes mixed with it, and from this it takes up oxygen, becoming converted into the insoluble indigo which is precipitated out.

As indigo blue or *indigotin* is insoluble in water, it follows that it cannot be used directly as a dye without being first made soluble. In order to dye with indigo it is first converted into indigo white by means of reducing substances—that is, substances which will take away a portion of its oxygen. It is to aid in the formation of indigo white that woad is added to the vat, because it helps to set up a certain kind of fermentation (butyric fermentation). A typical woad vat contains from 20 to 25 lbs. indigo, from 1½ to 5 cwt. woad, 20 lbs. bran or flour, 5 to 20 lbs. madder, and 24 lbs. slaked lime. The precautions necessary in preparing the vat cannot be entered into, but the operator must be skilful and experienced, the art of preparing the bath often being handed down from father to son.* When the vat is ready, which usually takes from two to three days, the wool or other goods are moved through the liquid for from 20 minutes to over an hour by means of a machine called a "hawking machine," they are then taken out of the vat and exposed to air, by which means the indigo white becomes oxidised to indigo blue.

Indigo blue is one of the fastest if not the fastest of blue dyes, and it is extremely stable to light and washing. The only fault it has is that it is apt to rub—that is, to colour other substances blue which are in contact with it, *e.g.*, the linings of dresses, &c. Very many attempts have been made to substitute other dyes in place of indigo, but it has always succeeded in holding its own, most other dyes lacking the rich hue and bronzy appearance produced by indigo.

A few years ago the Indian indigo manufacturers woke up with a start and found that there was an artificial indigo on the market—that is, an article which was made entirely by chemical means, and which was not dependent upon the growth of a plant. This artificial or synthetical indigo is made from products obtained from coal-tar and has exactly the same constitution and properties as the product produced from the indigo plant.

The manufacture of synthetical indigo is one of the greatest triumphs of chemical science. For more than 20 years German chemists had been engaged upon the problem of how to prepare indigo on a manufacturing scale. Professor von Baeyer had already in 1878 discovered what the constitution of indigo was, and had been able to prepare it in small quantities in the laboratory. But the problem of how to make it in quantity and cheaply took more than 20 years to elucidate, and the expenditure of enormous sums of money. Chemists all the world over were aware of the facts, but the indigo planters with a sublime indifference, unmindful of the fact that the great madder industry, and the manufacture of alizarine from this plant, had been abandoned owing to the advent of the coal-tar colour industry, went their way, treading in the old unscientific footsteps of their forefathers—we had almost said of the ancient Egyptians—until they were startled, as one of them picturesquely said, "by a bolt from the blue." Synthetical indigo was a reality.

As might be expected, there is a great deal of controversy as to the rival merits of natural and synthetical indigo. As a matter of fact, *indigotin*, the blue colouring principal of indigo, whether synthetically prepared or obtained from the plant, is exactly the same substance. But the indigo obtained from the plant is not pure, as it contains besides other impurities small quantities of indigo red, indigo brown, and a gummy substance called indigo-gluten, and the presence of these is said to impart a finer tone to the dyed articles. On the other hand synthetical indigo is quite pure, and the quality is always the same. The methods of the indigo planters have been unscientific in the extreme; now that the horse has been stolen they are locking the stable-door and have called in scientific advice. Improvements in the manufacture and better agricultural methods may, and probably will, postpone the final triumph of the synthetical indigo; but it is to be feared that this once flourishing industry will shortly be a thing of the past. It must be admitted that during the last six of seven years, since the introduction of synthetical indigo, the weather conditions have made it very difficult for the planters to obtain good crops, but even taking this into account the following figures, taken from a recent issue of *The Times*, are striking in the extreme. In 1894-5 there were 1,688,042 acres under cultivation for indigo; in 1902-3 the acreage had sunk to 574,654; the output of indigo had during the same period fallen from 237,494 cwt. to 73,908 cwt. For the five years, 1899 to 1900, the average export of indigo was 148,000 cwt. in 1903-4 it sank to 60,410 cwt., and the average price from 203 rupees for the *mound* (82 lbs.) to 148 rupees.

A good deal of the land, at one time under cultivation for indigo, is now being planted with sugar, and it is a matter of great importance for India that as the indigo is gradually forced out—we trust that the process may be a slow one—its place should be taken by some new product.

The subject of indigo cultivation and manufacture has been brought before readers of "KNOWLEDGE" in order to bring home the absolute importance of scientific knowledge and scientific research. If the Indian manufacturers had at the first sign of the appearance of synthetical indigo, in 1878, exerted themselves to understand the scientific problems underlying the production of indigo from the plant, we might not to-day see a waning industry. One has only to look at the wonderful progress of the beet sugar industry to see what can be done when chemical and agricultural improvements are carried on side by side.

* It must, of course, be understood that there are a great variety of methods employed in preparing an indigo bath, different baths being required for different kinds of work.

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Modern Cosmogonies.

By Miss Agnes Clerke.

XI.—The Procession of the Suns.

Phenomena are functions of time; and the form of the function has to be determined in each particular case. That is what the historical method comes to; and its use is prevalent and almost compulsory. We can no longer be satisfied with a simple bird's-eye view of the universe; our thoughts are irresistibly driven to grope into its past, and to divine its future. Static conceptions sufficed for our intellectual forefathers. They aimed at establishing the equilibrium of things, while we see them in a never-ending flux. One aspect of them calls up the next, and that another, and so on *ad infinitum;* we cannot, if we would, balance our ideas on the pivot of the transient present.

The immutable heavens of the ancients strike us today as the invention of a strange race of beings. We, on the contrary, see them with Shelley as a "frail and fading sphere"—a "brief expanse," the seat and scene of change. The "fixed" stars long ago broke away from their moorings, and began to flit at large through space. Of late, a less obvious, more intimate kind of mobility has been attributed to them. Grooves of individual development seem prepared for them, along which they shift as the tardy ages go by; and since everything that grows must decay, the orbs of heaven, too, incur the doom of mortality. Modern science, however, has done much more than extend to them the dismal philosophy of the phrase, "*tout passe, tout casse, tout lasse.*" The grandiose enterprise has been not unsuccessfully essayed of tracing in detail the progress of sidereal evolution, and of marshalling the vast stellar battalions in order of seniority. This has been rendered feasible by the disclosures of the spectroscope. Apart from their guidance, the track might have been glimpsed here and there, but could never have been laid down with any approach to definiteness. Herschel found for it a *terminus à quo* in nebulæ of various forms, but attempted to pursue it no further. We do not hesitate to run it on, from station to station, right down to the *terminus ad quem*—not, indeed, without the perception of outstanding difficulties and insecurities. They appear, however, to be outweighed by a certain inevitableness of self-arrangement in the visible facts.

The argument from continuity is that mainly relied upon. An unbroken succession of instances is strongly persuasive of actual transition, provided only that a principle of development (so to call it) may reasonably be assumed as influential. A series of mineralogical specimens, however finely differenced, does not suggest the progressive enrichment of one original mass of ore. In the stars, on the other hand, a species of vitality may be said to reside. They are not finished-off products, but self-acting machines. They are centres of energy, which they dispense gratis, supplying the cost out of their own funds. And the process is not only obviously terminable, but must be accompanied by constitutional alterations, which might be traceable by subtle methods of enquiry. They *are* traceable, unless we are deceived by illusory appearances.

Secchi's classification of the stars was unwarped by any speculative fancy. It was purely formal; it aimed only at providing distinct compartments for the convenient arrangement of a multitude of differently characterised items of information. Then by degrees, the close gradation of one class into the next came to be noticed; the partitions melted away; the methodised array showed itself to be in movement; and the bare framework took shape, under the auspices of Zöllner and Vogel, as a cosmic pedigree. The white stars were set forth as the progenitors of yellow, yellow of red stars; and the insensibly progressive reinforcement of the traits of relationship between the successive types went far towards demonstrating some partial, if not a complete, correspondence of the indicated order with the truth of things. It has since been found necessary to divide the first stellar class into helium and Sirian stars; and here, too, essential diversity shades off imperceptibly into likeness approximating to identity. All the groups hang together; the entire scheme is on an inclined plane of change. Helium stars, as they condense, pass into Sirian, these into solar stars; which finally, reddening through the increase of absorption, exhibit the badge of post-meridional existence in fluted spectra. The finality of the red stage is, indeed, very far from being absolute, but what lies beyond is matter of conjecture.

There are several good reasons for taking helium stars to be the "youngest," or most primitive of the amazing assemblage that sparkle in the vault of heaven. The first is their affinity with nebulæ. Every star, perceived to be involved in folds or effusions of shining haze, has yielded—if bright enough for profitable examination—a spectrum of helium quality. Further, they are remarkably tenuous bodies. It has been ascertained with some definiteness, from the investigation of stellar eclipses, that helium stars are commonly, perhaps invariably, of far slighter consistence than the sun. Radiation, however, is maintained by contraction; hence, orbs at the outset of their course must be, on the whole, the most diffuse. A third note of youth is membership of embryo systems; and this is affixed very markedly to helium stars. One-third, certainly, probably one-half of those lately submitted to trial by Professors Frost and Adams proved to have spectroscopic companions. They are pairs believed to have been recently (in the cosmic sense) divided by fission. And this is an operation which must, we should suppose, be undergone early, or not at all.

The spectra of helium stars are peculiar and suggestive. Those belonging to Miss Maury's earliest groups—many of them visibly nebulous—bear next to no traces of metallic absorption, showing instead lines of oxygen, nitrogen, and of hydrogen in all its three series. The conditions, accordingly, needed to produce the "cosmic" modification of hydrogen are realised in these inchoate bodies. What those conditions actually are, we cannot tell; yet it may be confidently surmised that they will prove to be of an electrical nature. Hydrogen resembles the metals in being electro-positive; it collects at the negative pole during the electrolytic decomposition of water. There is, however, an unmistakable tendency in primitive sidereal objects to display absorption-rays of electro-negative rather than of electro-positive elements. It is conceivable that hydrogen may be capable of altering its behaviour in this respect; and that the molecules radiating the Pickering and Rydberg series, in addition to the more familiar Huggins series, have, in fact, through some corpuscular re-arrangement, assumed the electro-negative quality properly characterising a non-metallic substance. The association of this form of hydrogen

with oxygen and nitrogen in early helium stars could thus be more naturally related to the simultaneous quasi-disappearance from them of the spectral badges of metals.

The helium-line most distinctive of this stellar family is situated well up in the blue. It appertains to the same vibrational sequence with D_3, which is also represented, at any rate in Rigel, a somewhat "advanced" Orion-star. Here, too, we meet a fairly prominent magnesium-ray, lying below the blue helium emanation; while as yet iron is unapparent. Numerous fine, faint streaks, due to its absorption, emerge, however, when the Sirian type is fully reached, and they are mostly of the "enhanced" kind. When the spark-discharge is substituted for the arc as the source of illumination, certain lines in the resulting spectrum brighten relatively to the others; and these have been distinguished by Sir Norman Lockyer as "enhanced." Now, the rule is strikingly prevalent that the absorption-rays in white stars are of this class; yet it can no longer be interpreted as indicating for them an excessively high temperature. Rather, it would seem that electrical conditions, still imperfectly defined, are in question; and their gradual removal, or subsidence, is, beyond doubt, largely instrumental in bringing about the transition to the solar stage. The effacement of helium-absorption is even more perplexing. No sooner does iron begin to show than it vanishes. There is still a faint trace of its "blue" line in Vega; none survives in Sirius.

In spectra of the solar type, two great bars of violet light are stopped out by calcium; otherwise, metallic arc-lines predominate, while those of hydrogen are no longer so powerfully emphasised as in white stars. Moreover, the whiteness of the unveiled Sirian photospheres has become tinged with yellow owing to the development of a shallow envelope partly impermeable to blue rays. For this reason, the comparative extension of their ultra-violet spectra affords, for stars of different types, no secure criterion of relative temperature. Sound in principle, it becomes inapplicable when the unknown factor of general absorption comes into play. The energy-curve of the solar spectrum as it is, can be determined; the energy-curve of the solar spectrum as it would be if unaffected by general absorption, has to be constructed from inference. But only bare photospheres give congruous results. Hence, there are no valid grounds for asserting that Sirius is hotter than the sun, or the sun than Betelgeux. It may be so, but the evidence at present available is inconclusive. The appearances expounded in this sense may bear quite different meanings.

The reasons for holding that solar mature into Antarian stars are of the same nature, and of equal cogency with those tending to prove their own development from luminaries of earlier types. There is a similar continuity of specimens. They can be ranged one after another in an unbroken series, in which, as we descend the line, primrose shades into orange, and orange into red, general absorption arrests an increasing percentage of the blue radiations, while specific absorption becomes strengthened by dusky flutings of titanium. Carbon-stars are less easily located. Dr. Vogel regarded them as co-ordinate with the Antarian class. The two varieties of red stars with banded spectra descend, in his opinion, from the common stock exemplified by our sun. Professor Hale also favours this view, some attendant anomalies notwithstanding. His photographs have certainly established for carbon-stars links of relationship both with the Antarian and the solar families; yet the fact remains indisputable that the carbon type is, to a great extent, isolated from all the rest. Tokens of a genuine migration towards it are few and obscure.

The ultimate fate of both tribes of red stars can only be conjectured. Most vary in brightness, some to the verge of periodical extinction; and variability may be a symptom of interior dilapidation. The constitution, however, of such objects is still enigmatical. They appear to be exceptionally remote and inaccessible to enquiry. No indications have been gathered as to their density or intrinsic light-power. Very little is known about their movements. They rarely form binary combinations, and those that they do form are almost always relatively fixed. No red star travels in a computed orbit; only one, η Geminorum, occurs on the long list of spectroscopic binaries. The revolutions of this curious system ought to prove, when thoroughly investigated, of high interest and instruction.

Coupled stars offer special opportunities to students of cosmogony. They are obviously contemporaries; they have started fair; identical influences have acted upon them; hence differences in their standing can only result from dissimilarities in mass or composition. It is commonly taken for granted that a body containing less matter than its fellow must develop faster, and incur the final quenching sooner. But Sir William and Lady Huggins have adverted to the probability of the very opposite being the case. Powerful surface gravity may, they consider, serve to hasten the transition from a Sirian to a solar spectrum; and we should then have giant suns like Capella advanced in type while at a very early stage of condensation. This, perhaps, explains the remarkable spectral relations of contrasted stellar pairs. Always, so far as we yet know, the Sirian spectrum is yielded by the lesser star, the mass of which, judging by analogy, must be small even below the proportion of its faintness. It is true that the distribution of mass in binary systems is often widely different from what might have been anticipated. Certain purplish satellites, for instance, of undetermined spectral quality exercise a gravitative sway of surprising force. Some results of this kind, lately obtained by Mr. Lewis and others, are likely to prove of fundamental importance to theories of stellar evolution.

What we know of "dark stars" has been mainly derived from the observation of stellar systems. They are assumed to be the denizens of a stellar Hades, dim wanderers amid the shades, who "have had their day, and ceased to be" as suns. In the "cold obstruction" of these viewless orbs the grand cosmical procession is held to terminate. Their presence attests the downward progress of decay, and gives logical completeness to the argument for development. Yet there are circumstances warning us against too full an assurance that their status is really that of skeletons at the feast of light. They are very frequently found to be in close attendance upon brilliant white stars. Thus intimately, if incongruously coupled, they circulate, and compel circulation in brief periods, as members of systems just, it might be said, out of the shell. What are we to think, for instance, of the obscure body spectroscopically discovered to control the revolutions of the chief star in the Orion trapezium? It is evidently comparable in mass with that imperfectly condensed luminary; is it credible that it has already traversed all the stages of stellar existence, and cooled down to planetary rank? So violent an assumption

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should, at any rate, not be made without due consideration; and we may more prudently hold our judgment in suspense as to whether globes so circumstanced—and they abound—should be regarded as effete, or as abortive suns.

Speculations on the exhaustion of stellar vitality have, however, lately become inextricably involved with the complex problem of elemental evolution. A dim inkling has been acquired of the working in the universe of obscure forces, availing, we can just see, to falsify many forecasts. The theory, at least, of the dissipation of energy needs important qualifications. Nor was it propounded by Lord Kelvin with dogmatic certainty. He carefully noted the possibility that in "the great storehouses of creation" reserves of energy might be provided by which the losses incurred through radiation could be, wholly or in part, made good.* The anticipated possibility is, perhaps, realised in the phenomena of radio-activity. But if we enquire how, we are met at the threshold by difficulties connected with the origin of helium. Helium appears to result from the disintegration of radium, its generation being accompanied by the setting free of enormous quantities of energy. Its copious presence, then, argues long-continued and lavish expenditure of heat and light. Yet it is as a constituent of highly primitive orbs that it is chiefly conspicuous. Gaseous nebulæ, too, include immeasurable supplies of it, while it is incompatible with whatever we seem to know about them to suppose that radium at any time entered into their composition. In truth, however, the genesis of the elements has not yet been made the subject of coherent speculation. Current ideas regarding it imply a double course of change, by aggregation first, and subsequently by disintegration. And this should give us a two-fold series of elements. On one side, there should be fixed survivals of the advancing process, on the other, products of decomposition, continuously evolved, and even now accumulating. If the claim of helium to take rank among these last should be finally established, our conceptions of the nature and history of nebulæ might have to undergo a strange inversion; but the outcome of the researches in progress is still uncertain, and may be far off.

It is, however, quite clear that the electronic theory of matter supplies no genuine explanation of the source of energy in the universe. What is given out when the atoms go to pieces must have been stored up when they were put together. Whence was it derived? This is the fundamental question which underlies every discussion concerning the maintenance of the life of suns. It is unanswered, and probably unanswerable.

* Thomson and Tait, *Natural Philosophy*, Appendix E, p. 494, edition 1890.

Physiology.—Mr. E. H. Starling is to be congratulated on the little "Primer of Physiology" (John Murray). It is an attempt to convey with as few technical terms as possible the leading ideas which make up present-day physiology. That is rather a formidable task in a book of some thirty thousand words; but Mr. Starling not only does succeed in conveying a very clear idea of the way in which the normal processes of life are carried on, but does it without the sacrifice of any essential fact, and with—as for example in the chapter on serums—the illumination of the latest theory.

Rare Living Animals in London.

By P. L. Sclater, Dr.Sc., F.R.S.

III.—Grévy's Zebra.

The herd of Grévy's zebra in the Zoological Society's Gardens in 1903, consisting of a male and four females, was, in my opinion, one of the finest groups of the class of mammals ever shown by the Society. Unfortunately, both the males have lately died, but an adult and three younger females still remain, and exhibit the form and markings of this beautiful animal—the most remarkable of all the living members of the Equine Family.

As to the perfect distinctness of Grévy's zebra from all the various forms known as Burchell's zebra and its other congeners there can be no longer any question. The larger size, broader ears, white belly, and entirely different style of banding render this splendid animal recognisable at first sight, as will be seen by Mr. Goodchild's drawing, which has been taken from the adult female of this species placed by her late Majesty Queen Victoria under the care of the Society in 1899, and still living in the Regent's Park.

Although probably well known to that most observant naturalist, Emin Pasha, who appears to have met with this animal in Latako in the Equatorial Province of the Sudan, the first specimen of Grévy's zebra to arrive in Europe was a living example, sent as a present by the Emperor Menelek in 1882 to M. Grévy, then President of the French Republic, and deposited in the Jardin des Plantes.* This was long before the "Fashoda incident," when France, in the eyes of the Abyssinians, was more potent than England. On hearing of the arrival of this novelty I hurried over to Paris to inspect it, and was rather disappointed to find the zebra already dead and an inhabitant of the Mammal-Gallery of the *Muséum d'Histoire Naturelle*. I saw at once, however, when I came to examine the specimen, that it was widely different from all other known zebras, although I had some little difficulty in persuading my friends at the Zoological Society that such was really the case.

In 1890† I was able to give the Zoological Society further evidence of the distinctness of *Equus grévyi* from the other zebras, and to show that its distribution extends from the southern frontiers of Abyssinia into Somaliland. A flat skin, obtained for me in Western Somaliland by Herr Menges, through the kind intervention of Herr Carl Hagenbeck, was found to belong unquestionably to *Equus grévyi*, which, in fact, appears to be the only zebra met with in that country. In his excellent work on Somaliland‡ Capt. Swayne gives us the following particulars concerning his experiences with this animal:—

"Grévy's zebra, although first described by the French, had been shot in Somaliland by Col. Paget and myself on our expedition of 1893. I found it at Durhi,

* See Proc. Zool. Soc., 1882, p. 721. The specific name *Equus grévyi* was based on this specimen by the late Alphonse Milne-Edwards (*La Nature*, No. 474).

† See P.Z.S., 1890, p. 443.

‡ "Seventeen Trips Through Somaliland. By Capt. H. G. C. Swayne, R.E.; London, 1892.

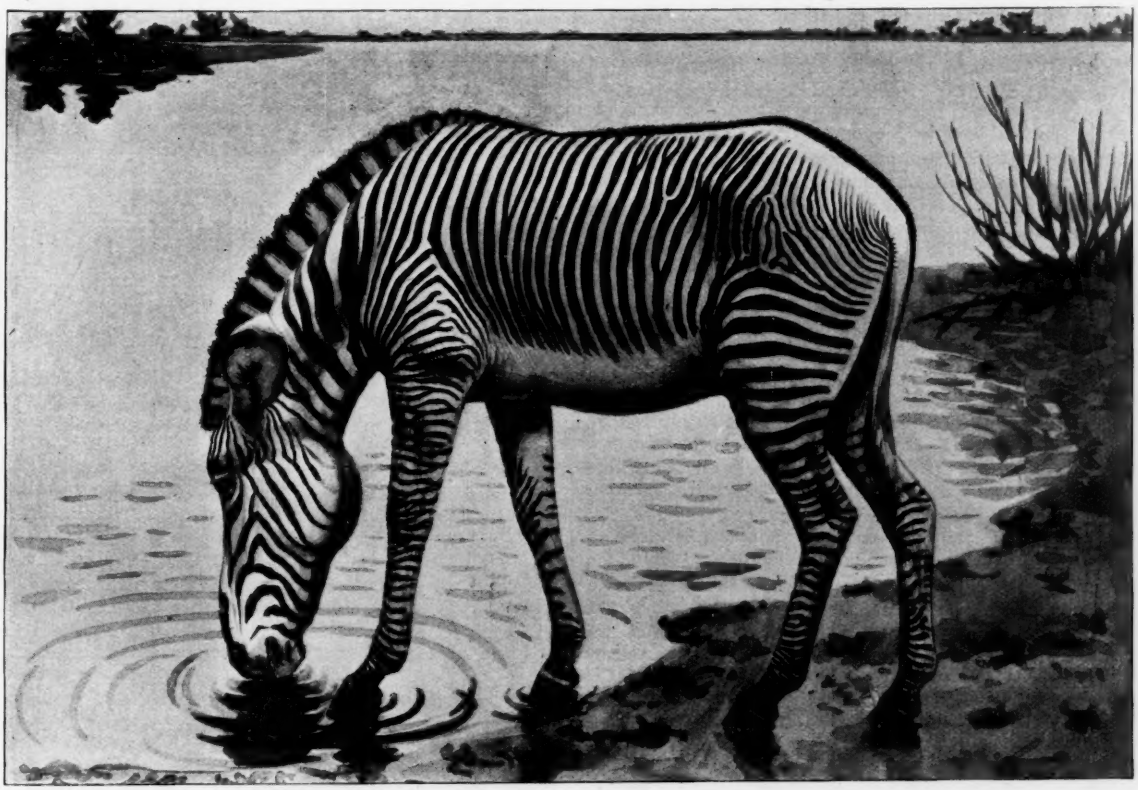
in Central Ogaden, between the Tug Fáfan and the Webbe, about three hundred miles inland from Berbera, and shot seven specimens. . . . . This zebra is very common in the territory of the Rer Amáden and Malingúr tribes. The country there is covered with scattered bush over its entire surface, which is stony and much broken up by ravines, the general elevation being about two thousand five hundred feet above the sea-level. The zebras which I saw (probably not more than two hundred in all) were in small droves of about half a dozen each, on the low plateaux covered with scattered thorn-bush and glades of *dura*-grass, the soil being powdery and red in colour, with an occasional outcrop of rocks. In this sort of country they are very easy to stalk. I saw none in the flats of the Webbe valley, and they never come so far north as the open grass plains of the Haud, Durhi, south of the Fáfan, being, I think, their northern limit."

About the range of Grévy's zebra on the Abyssinian side, and whence the living animals sent to Europe by the Emperor Menelek were obtained, we have no such exact information. In 1895 the well-known American traveller, Dr. Donaldson Smith, gave us the following account of the distribution of Grévy's zebra so far as he was acquainted with it:—

"Commencing 20 miles east of the Shebeli River, the range of Grévy's zebra extends about 120 miles to the west; it is limited by the second and eighth degrees of latitude. On passing the Juba River you find Burchell's zebra in great herds among the mountains of the Boran country, but no Grévy's zebra until Lake Stephanie is reached. Here you find the ranges of the two species overlapping to a certain extent, but about Lake Rudolph I met only with Grévy's zebra."

It is probable, therefore, that the Grévy's zebras brought from Abyssinia were obtained from the country north of Lake Rudolph.

The Grévy's zebras exhibited in the Zoological Society's Gardens have been altogether six in number. The first pair, which were presented to Queen Victoria by the Emperor Menelek, arrived on August 14, 1899. The Emperor subsequently sent two females of the same zebra to King Edward, which were placed under the Society's care on July 12, 1902, and in the following year a fine young pair was presented to the Society by Lieut.-Col. Sir J. L. Harrington, K.C.B., H.M.'s Envoy at the Abyssinian Court. Both the males have been unfortunately lost, and the present stock in the Society's Gardens consists of females only. There are also one or more females of Grévy's zebra in H.G. the Duke of Bedford's menagerie at Woburn.



Grévy's Zebra.

(From an Adult Female in the Gardens of the Zoological Society of London.)

The form of the group of Burchell's zebras that extends furthest north, and is probably that which Dr. Donaldson Smith alludes to as in some places "overlapping the range" of Grévy's zebra is commonly called Grant's zebra (*Equus granti*). There is one example of this zebra also in the Zoological Society's Gardens at the present time.

XUM

Natural Mummies.

By Frances A. Welby.

In the ancient parish church of Venzone, situated in the extreme north of Italy, some twenty miles above Udine, at the bifurcation of the valley known from time immemorial as the Canale di Ferro (long the high-road to Germany, and still to Carnia—up which, on the one hand, the railway passes to the Austrian Frontier at Pontebba, while, on the other, the historic River Tagliamento flows down from the Carnic Alps to the plain of Friuli) are thirteen tombs that possess the natural property of mummifying, or, more properly, desiccating, the bodies deposited in them. In the course of one year or less, more certainly in two, such bodies, clothed and placed in wooden coffins, are as a rule completely transformed, and become dry and light, and yellowish-grey in colour. The skin remains intact and resembles parchment; the bones are perfect, held in place by the dried ligaments and articular capsules, more or less covered with muscular and tendinous fibres, which, with the nerves and blood-vessels, adhere together in a desiccated mass. Teeth, hair (beard, eyebrows, eyelashes), and nails are all preserved in astonishing perfection, the fluid parts of the body alone disappearing. When extracted from the tombs, the mummies are covered with a layer of dark yellowish mould or fungus, that disappears little by little, and the cutis, at first blackish and flexible, becomes a pale yellow, in colour and texture exactly like sheepskin. They are extremely light in weight, varying from three to six kilograms.

The process is not effected with equal rapidity in all cases, and fails altogether in some instances (in which ordinary dissolution then takes place)—the reasons for this not having been discovered. The tombs in the church are twenty in number, but only thirteen, as said above, have this property of desiccation, and of these, again, seven succeed much better than the others. All are constructed with brick walls, cemented with common lime, and closed hermetically with slabs of stone or marble. It is, however, a curious fact that the process is not inhibited by the free admission of air and water, one of the most perfect mummies having actually been discovered floating in water. In dimension the tombs are about 1 metre 90 in depth, by 1.50 in width, and 2.00 in length. The inscriptions on the covers show that they belonged for the most part to ancient and noble families of Venzone, but three at the foot of the choir deserve special mention. The first held the remains of one Boleslaus, Duke of Schlesia, who had, perhaps, returned from the Crusades in the suite of the Emperor Conrad III., in 1149; in another rested Agostino, Prior of Brüm in Moravia, and Bishop of Concordia, Vicar Patriarchal, who on June 22, 1392, was slain on the banks of the Tagliamento by Nicolò Savorgnan for complicity with the Patriarch in the murder of Federico Savorgnan, his kinsman; and the third must have covered a pilgrim, since the stone is inscribed with the words, *hic jacet Laurentius de Bacia*, and a rude sculpture of a hand holding a pilgrim's staff.

The first mummy was discovered in 1637, when, in rebuilding the Chapel of the Rosario, a sarcophagus inside the church (now standing outside the North door) was opened. Within it was found a coffin in good preservation, and within that a handsomely-clothed mummy also in good preservation. The tomb bears the arms of the Scaligeri, with two sculptured angels carrying away the soul of the departed. From its velvet wrappings, the mummy presumably belonged to this family. Unfortunately all the ancient records of Venzone were destroyed by fire in 1547, so that no previous documents exist to throw light on this, and, perhaps, earlier discoveries. The *Gobbo* (Hunchback), as he is called, is still preserved, and, like the rest of his companions, shows no sign of perishing from exposure, though he has suffered considerably from the rough handling of injudicious visitors. For many

years no more was thought of the phenomenon, until in the 18th century other similar mummies were discovered in other tombs, after which a number of successful experiments were made (eighteen up to 1831, twenty-one after that date), until burial in the church was prohibited for sanitary reasons. The last two were exhumed in September, 1901. The Venzonese frequently go to look at their relatives, and take pride in recalling familiar characteristics. The broken arm, *e.g.*, of one of the latest subjects, is demonstrated with much satisfaction.

Napoleon I. visited Venzone in 1807, and proposed to make an Imperial Necropolis in the little mountain city, but upon his downfall the project was abandoned. Francis I. of Austria, in 1819, and Ferdinand I. in 1848, also visited this strange cemetery.

The thirty-two extant mummies are ranged round

the wall of an adjacent chapel, the ancient Oratory of S. Michael—a grim and ghastly company. From waist to knee they are clad in a decorous white kilt or loin-cloth, the ecclesiastics being somewhat grotesquely distinguished by birettas. Rosaries are still clutched in some of the poor desiccated fingers; the hands of one are clasped over his breviary. Women as well as men are there; the erstwhile notion that only the male sex were susceptible of mummification having been exploded by the discovery in 1826 of a very perfect female subject, who had died of typhus in 1816. The smaller number of female mummies is doubtless due to the fact that these tombs were usually reserved for priests and persons of distinction in the community.

It is notable that the phenomenon occurs not only in the parish church, but also in the Chapel of S. Catherine, a little to the east of Venzone, where is one tomb in which the remains become completely transformed, and where the body of Don Felice Tavoschi of Tolmezzo, the well-loved pastor of Venzone, who succumbed to cholera in 1855, is preserved to this day by the affection of his people. At Ospedaletto, too, three miles nearer Gemona, five similar tombs are known to exist in the ancient Priory of the Santo Spirito. And animal remains, in a perfect state of desiccation, have been picked up upon the plain of Portis, three miles above Venzone, on the road to Tolmezzo; so that it would appear as though for a radius of some six miles round Venzone, human and other animal remains, buried in the earth, or more particularly in the tombs of the churches, are in this singular manner more or less frequently converted into mummies.

The phenomenon has naturally given rise to much scientific discussion, though it appears still to be an unsolved problem. The latest writer, Dr. Paré (1870), exclaims with pardonable sarcasm that "had such a rare phenomenon occurred within 19 Italian miles of Paris instead of Udine, the French Academy would have appropriated it, would have subjected it to most searching examination, and would have published monographs of Atlantean magnitude, which, in proportion as they rose in price, would be treasured in the most illustrious libraries."

Dr. Ciconi in 1829 suggested that the desiccating agent might be the calcium sulphate, which, in a more or less anhydrous form, and mixed with calcium carbonate, constitutes the soil of Venzone and Ospedaletto. This comes from the limestone débris of the Carnic Alps brought down by the Fella and the Tagliamento. He points out that anhydrous sulphate of lime, which absorbs water avidly, was the principal substance used by Hunter in his celebrated process for preserving the human subject, and suggests that the imperfect desiccation occurring in some of the tombs would be due to their having been excavated above or below the beneficent layer. Marcolini in 1831 put forward a hypothesis that the acidification of the soil by hydro-carbo-phosphates might be the cause owing to which the natural processes of corruption were inhibited. Stringeri maintained the same idea a decade later. But Dr. Zecchini in 1861, and Dr. Paré (Director of the Hospital at Udine) in 1868-70, independently brought forward the theory that the desiccation was produced by a parasitic mould, *Hypha bombastica Pers*, which absorbs the aqueous humours of the body, and induces mummification. This mould is invariably present on the surface of the mummies, covering them here and there, in greater or less profusion, and persisting for a long while after their exhumation and exposure. But by previous observers it had been regarded as the *effect* and not as the *cause* of the phenomenon. It is a microscopic parasite, composed of white fungoid flocculi, analogous to the *Botrytus* or parasitic fungus that produces "*calcino*" in the silkworm. In 1870, Dr. Paré made a series of experiments in which he succeeded, by sprinkling various animal remains with Hypha from the Venzone mummies, in obtaining successful preservations of frogs, eels, and cats; while, on the contrary, he failed with fishes (apparently on account of the scales), and with a dead lamb (perhaps because the Hypha, nourishing itself upon the fatty humours of the wool, was unable to attack the body before it underwent decomposition). He explains the successes and failures in the human subject by the conflict between the Hypha or preservative agent and the processes of decomposition, the one or the other predominating according to circumstances. It is obvious from his experiments that the phenomenon is common to all animal remains, and is by no means peculiar to the human body.

Other similar mummies have been found in the Cathedral of Tolouse, in the Church of S. Michael in Dublin, and in the ancient Servite Monastery of Monte-all-Croce near Bonn; but they are less perfect than those of Venzone. A parallel has also been sought in the mummies found in the burning sands of Arabia, but at Venzone the phenomenon cannot be due to heat, as the temperature of the tombs is very low. Nor is it produced by the action of cold, otherwise the mummies would decompose at the temperature of the air, like those of the Arctic Regions. They are impervious to the action of air, and even of water; while the desiccating and preservative agent is able to resist even such potent forces as the putrefactive processes of typhoid fever.

NOTE.—The probable action of a parasitic fungus upon the "Venzone Mummies" is borne out by Mr. Massie's article in "KNOWLEDGE" for October, 1904, in which he mentions the *Botrytus*, by which the silk-worm is completely desiccated, or calcified—a too-familiar phenomenon in the silk-worm districts of Italy—and other forms of "mummifying" fungi.

Further information as to the probable cause of the phenomenon at Venzone would be welcomed by the writer, who failed, during a prolonged stay at Udine last year, to obtain any reliable scientific explanation of it.

Explosion of Stars.

By PROFESSOR A. W. BICKERTON.

Do stars explode? Are the observers of Lick and Yerkes correct when they said that Nova Persei had become a nebula that was expanding at such a rate that no theory of its origin was tenable, but that a star had exploded, been converted into gas, and blown at a velocity of thousands of miles a second to spread itself throughout the entire universe?

Is it conceivable, with the known laws of matter and energy, that a force can be generated great enough to blow a star to pieces? A calculation shows that were the entire star an explosive, it would have to be a score of thousands of times stronger than dynamite. Is there in Nature anything in which such a store of energy exists? This question must undoubtedly be answered in the affirmative, and the source of the energy is the attractive force of gravitation. The force with which the sun attracts matter, and the enormous

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distance through which this force extends, gives us an energy so great that, without any original motion, a particle falling from the nearest star upon the sun would reach it with a velocity of three hundred and ninety miles a second. This velocity would possess an energy hundreds of millions of times greater than that of an express train, and the temperature produced by the stoppage of the motion would excel that of an electric furnace a score of thousands of times.

Hence, in the collision of suns we have an agent that may generate energy sufficient to cause the sun to explode, but so enormous is the mass of a sun, that the energy of collision has been shown to be too small to blow the sun into a nebula; but the probabilities of a direct, complete collision between suns is small indeed. Any original motion or any attraction of other bodies acting during their fall towards one another, would tend to make the impact of a tangential character, and it is upon the study of tangential impact that the solution of our problem depends. The velocity with which two suns would sweep past one another would be so great that a slight graze would not stop them. They would fly past one another, scarred by the encounter; but the portions that lay in one another's path, and that did actually come into collision would be swept from the remainder, would coalesce, and would form a new body in space. The tremendous motion would be converted into heat, and the mass of the new body, if the graze were not deep, might be so small that the explosive pressure produced would blow it into a nebula that would continue to expand with an enormous velocity, and every particle be finally dissipated into free space; in some cases leaving the very universe itself.

It is thus seen that the numbers and distribution of the stars must, on the demonstrated laws of Nature, produce an explosion; and it is highly probable that all the so-called temporary stars that have appeared at intervals in the heavens, usually increasing in brilliancy for some hours, or a day or two, and then gradually disappearing, are caused by partial impacts of stars or, in most cases, of dead suns. For all these bodies have similar spectra crossed with doubled lines, the one showing recession, and the other approach, indicating the two scarred suns that have struck one another; whilst the brilliant continuous spectrum seen in all new stars, for some time after the outbreak, is due to the mass of flaming gas that must expand at the rate of some million of miles an hour.

The velocity with which these bodies pass one another would cause the impact to be over in an hour or less; and in this time a body is produced with a higher temperature than that of any ordinary star. This brilliant body would soon expand until the globe of fire would be thousands of times the volume of the sun.

Hence we need not be surprised that Tycho Brahe's new star grew to be more brilliant than Jupiter, even more brilliant than Venus at quadrature; so intense, in fact, as to be visible at noonday. Nor need we wonder at its disappearance, for the flight of its myriad molecules all travelling from the point where the explosion occurred, would rapidly tend in their radial outrush to become parallel, and the molecules consequently cease to strike one another save at intervals; and as molecules only radiate immediately after encounters, it is obvious that, as these encounters become fewer in number, the luminosity of the mass would lessen and go on lessening until it was absolutely lost to vision.

Herschel has told us that the only possible explanation of the character of the many planetary nebula that he discovered was that they were hollow shells of gas. Every stellar explosion that is produced by a partial impact must result, at one stage of its history, in a planetary nebula that may be permanent or evanescent according to the attractive power of the new body as compared with its temperature.

Thus evanescent planetary nebulæ would be produced by slight grazes, whereas a deeper graze might produce a permanent planetary nebula, and still deeper grazes result in a large ratio of the molecules being attracted back, and producing a star in the centre of the nebula. Examples of this are comparatively numerous in the celestial vault.

So that our observers were doubtless right in the conclusion they came to that "Nova Persei" was a celestial explosion in which a star had been blown to pieces. And this fragment of the study of impact shows how important an agent impact is in astronomical evolution, for it must be remembered that all kinds of impacts may take place, from a mere graze up to a complete impact. Impacts may take place between dead suns or lucid stars. They may take place between meteoric swarms, or between star clusters. The impact of nebulæ may range from a mere graze through deep cuts, up to entire coalescence; and every form of impact save direct centre to centre must result in rotation, and obviously furnishes an explanation of the spiral character of so many thousands of nebulæ. Again, such vast bodies as the two magellanic clouds may be approaching one another, and after countless ages may impact, and should they strike deep enough into one another, coalescence of a whirling character would result, giving a galaxy of stars of a double spiral character, and spreading the poles of the ring with masses of nebulous matter, a configuration that exactly corresponds with the structure of our universe, and hence may we not ask the question, "Is not our visible universe a result of the coalescent impact of two previously existing universes, and if so may not such cosmic systems exist in endless number throughout the infinity of space?"

Such are the lofty conceptions that develop themselves from the study of impact, carried fearlessly to its legitimate conclusions.

Photography.

Pure and Applied.

By Chapman Jones, F.I.C., F.C.S., &c.

The Use of Colour Screens with a Low Sun.—In the September number I wrote:—"As the sun gets low the daylight gets markedly more yellow, and we have from time to time been instructed that the excessive blue sensitiveness of gelatino-bromide plates becomes so far negatived on account of this change, that it is not necessary to obviate it by the use of a yellow or orange-coloured screen. Whether or not this is so depends on what the photographer wants. If he seeks to photograph an evening effect as if it were lit by such light as given by the sun only when he is high up in the heavens, while the general effect is such as can be obtained only when he approaches the horizon, then he may omit the coloured screen. But if his aim is to photograph the scene before him as it is, there is

as much need for the yellow screen at sunset as at midday." I learn from the columns of a contemporary that this passage has "sadly troubled" him and at least two of his readers. This I regret, but would suggest that those who wish for further explanations of any matter in these chapters would do well to address our editor, or me through him, as then they will be certain of getting such assistance as I can render. I cannot undertake to read other journals for the sake of finding comments on what I say here.

The point of the above extract is that the excessive blue sensitiveness of the plate is an error of the plate, and if not compensated will produce its effect in a photograph taken when the sun is low as well as when the sun is high. That if the partial loss of blue light as the sun gets low (the light becoming yellowish by reason of this loss) is accepted as compensation in photographing late in the day, and the yellow screen is discarded, then the colours of the objects photographed will be rendered in the photograph as if they were lit by a midday sun and the yellow screen were used. It would be an anachronism to represent an evening scene with a low sun as if the quality of the light were such as we get only with a comparatively high sun—but we are so used to errors of this kind in photography that our sense of criticism is dulled. The error is in the plate, and whenever the plate is used the screen should be used if it is desired to represent the scene as it appears when photographed.

Indoors it is possible to use a yellow light instead of a screen, and it will be found that ordinary gas or lamp light will compensate the plate error to about the same extent as a yellow screen that requires the exposure to be increased four or six times. But the photograph taken by gas light will not render colours as they appear by gas light, but as they would appear by a whiter light more similar to daylight. If one has a colour screen that is made to properly compensate the errors of colour sensitiveness of the plate, then the screen should *always* be used when it is desired to render colours with the tone values as they appear at the time of photographing them.

The Royal Photographic Society's Exhibition.—Although the relation between the dates of the opening of this exhibition and the publication of this journal renders it impossible to refer to any of the exhibits until after they have ceased to be on view, there are a few points connected with the scientific and technical section that it may be of interest to refer to. The making of a series of consecutive photographs of changing objects at suitable and stated intervals so as to show the character and progress of the change, is an application of photography that has much to commend it. There were several examples of such work this year as there have been in previous exhibitions, the most notable being a series of seventy photographs by Mr. W. M. Martin, showing the embryology of a chicken. Of this series some were taken by transmitted light, some by a combination of transmitted and reflected light, and one by Rontgen rays; that is, the illumination was varied in order to best show the required detail—a consideration in such work that does not always receive the attention that it might. The application of Rontgen rays to the demonstration of internal and hidden structures was exemplified in a novel way by Dr. Rodman in a number of radiographs of Mollusca. The internal anatomy of each shell was shown with surprising clearness, and the systems of complex and superposed curves often formed figures of great beauty.

A portrait taken with ultra-violet radiations obtained by means of the screen devised by Professor R. W. Wood was shown by Mr. Edgar Senior. It merely demonstrates in a striking way the possibility of photographing an object quite in the dark. The portrait was very passably focussed, considering that the object and the image were both invisible, and that lenses are not corrected for the purpose of using them in this eccentric manner. A telephotograph of the upper part of St. Paul's Cathedral, by Mr. A. E. Smith, was an excellent production from a technical point of view. The magnification was twenty-four diameters, and as one thousand feet of London atmosphere intervened between the object and the camera, it was an excellent illustration of how an almost hopeless task may be successfully accomplished by selecting suitable conditions. Those interested in Mr. J. Hort Player's ingenious method of copying engravings, &c. (Player-type), will be glad to know that Mr. Player showed some very satisfactory enlargements produced from negatives obtained by his process.

Coloured Films.—The necessity for controlling the character of the light that may be available is ever present with the practical photographer. Too often he has to be content with some commercial article made for a quite different purpose that happens to be sufficiently near to what he requires to be serviceable. Bookbinders' cloth, coloured tissue paper, hock bottles, and other such makeshifts, are still commonly used, though in a few cases the demand has been met by more suitable and specially-prepared media. A further step in the right direction has recently been made by Dr. G. Krebs, of Offenbach-on-Main, who has put upon the market a considerable assortment of tough coloured films, specially made for the various purposes for which coloured media are required. They are known as the "Geka flexoid filters." Many, if not all of them, have been prepared from formulæ suggested by Dr. Miethe. I have examined several, and can confirm the statement that they do, practically speaking, absorb that part of the spectrum that they are stated to in the description of them, and that they form such series as are most generally needed. There are a yellow and three red films for dark-room lamps, transmitting the red and green, the red alone, the red beyond wave-length 610, and the red beyond about C, respectively; yellow films of three depths for use with orthochromatic plates; blue, green, and red filters for three-colour work, and many others of various kinds. They are obtainable in sheets of all sizes up to 15 by 12, and even larger, from the importers, Messrs. A. E. Staley and Co.

School of Art Wood-Carving.

The School of Art Wood-Carving, South Kensington, which now occupies rooms on the top floor of the new building of the Royal School of Art Needlework in Exhibition Road, has been re-opened after the usual summer vacation, and we are requested to state that some of the free studentships maintained by means of funds granted to the school by the London County Council are vacant. The day classes of the school are held from 10 to 1 and 2 to 5 on five days of the week, and from 10 to 1 on Saturdays. The evening class meets on three evenings a week and on Saturday afternoons. Forms of application for the free studentships and any further particulars relating to the school may be obtained from the Manager.

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A School on the Ocean.

AMERICAN educational enterprise is responsible for the scheme of a "Nautical Preparatory School"—in other words, a school on board a ship that is constantly afloat in the various maritime regions of the world. A vessel of this kind, to effect its purpose, must, of course, carry a professorial staff, whose members are qualified to conduct the education of pupils, as well as look after their moral and material welfare. But the studies of sea-going scholars of this type, while akin to those which form the curriculum pursued within the four walls of a high-grade establishment on shore, are supplemented by the novel opportunities and ever-changing environment of a cruising vessel.

The *Young America*, the craft on which this bold experiment in educational methods is to be carried out, is a newly-built full-rigged sailing ship, the keel of which was laid at Newport, Rhode Island, in the summer of 1902. She has a displacement of about 3,000 tons, and length of 262 feet, and is claimed to be of the most modern type of marine architecture. Electrically lighted throughout, the vessel is provided with all the requisites of up-to-date sanitary and hygienic science, and also those which meet the peculiar needs of a wayfaring ocean school. Two steam launches are borne, and ten rowing and sailing boats of navy pattern.

The *Young America* sailed from Newport on her first voyage in September last, and it is of interest to note that the maiden cruise of the ship is to this country, Edinburgh having been selected as the first city or port of call, and London as the second.

Our visitor carries upwards of 250 American lads, denominated "cadet pupils," and, as at present arranged, a complete student course for these occupies four years, during each of which an itinerary of cruises is performed to various parts of the world. It is not, however, obligatory to enrol for the whole period. In the first year, 16,000 miles will be traversed. From Edinburgh and London the ship proceeds to Christiania, Copenhagen, Gibraltar, the Mediterranean, the ports of the West Indies, and thence home to the United States, when a vacation of four months ensues. During the second year, Lisbon, Venice, Constantinople, and Santiago comprise a few of the ports of call of the cruise. The third year the ship visits St. Helena, Cape Town, Bombay, Calcutta, Hong Kong, Yokohama, and San Francisco. In the fourth and last year, Hawaii, Sydney, Hobart Town, Valparaiso, Rio de Janeiro, St. Thomas, and Charleston are among the ports of call. Vacations follow each ended cruise.

At first sight it would seem that here a training-ship is the central idea of the plan. But the school on the *Young America*, it is requisite to state, is not primarily designed to train boys for sea service, though, doubtless, in the nature of things its associations and influence will in many cases assist what may be the embryo stages of naval careers of the future. Strictly speaking, it is a school on a ship, and not, in the more limited sense, a school-ship. The cadets take no part in the working of the vessel, except for purposes that accompany the routine of discipline, drill, gymnastic exercise, and the ability to hand, reef, and steer. From the last-named operations there is no escape.

Notwithstanding that the actual work of the ship is carried on independently of the cadets, the organisation is planned on naval lines. The *Young America* is commanded by an experienced officer detailed under the provisions of the United States Navigation Laws, and the disciplinary standpoint is similar to that of the world-renowned United States Naval Academy. The cadets are formed into companies, and the companies into sections, the respective ranks in the latter being: cadet officers, cadet lieutenants, midshipmen, and probationers. Boys in the highest grade act as officers of the watch, performing duties identical with those of the ship's officers of like rank, only, however (so it is said), for purposes of physical development, amusement, or as a reward of merit, the duties themselves being carried on outside school hours.

A service as well as a dress uniform is worn, while other articles of clothing conform to the standard patterns. Such, in brief, is the naval aspect of the ship's management; the rest is an affair of the teaching faculty.

A body of 25 professors conduct what are called collegiate and commercial courses. The former comprises an educational training for cadets who subsequently intend entering American colleges, the U.S. Naval or the U.S. Military Academy, or to secure a liberal education independently of attendance at any higher institution. The plan of the latter course is laid on broad lines, the object of which is to impart a sound general education, coupled with a practical knowledge of the world's commerce, derived as much as possible from personal observation in widely differing countries. In both sections the teaching of modern languages is a feature; those that may be taken up are: French, German, Spanish, and Italian. Certain of the cadets are instructed in theoretical navigation, and steam and electrical engineering. Considerable attention is to be given to various branches of science—indeed, in some respects, the *Young America* modestly subserves the functions of a scientific and exploring expedition. Under the fostering eye of a competent Director of Science, Prof. Porter E. Sargent, deep-sea dredging will, with suitable equipment, be pursued, and the treasures and wonders of the tow-net set forth and explained. Then it is hoped that the visits on shore during the ship's "globe-trotting" will afford ample facilities for judicious scientific collecting.

It is not to be expected that the gates of the world will fly open to these cadet pupils; and we may hope that they will not broaden into sea prigs. Still, it cannot be doubted that the world-wide travel that is forecasted, in alliance with scholastic training, will be of high advantage if properly assimilated and adjusted to the needs of after-life requirements. It is a grand tour of the seas, and round-the-world itinerary of cities and sights of peculiar significance. A broad hint has been given that America's foreign trade should ultimately receive stimulus, and new outlets crop up for the development of her industrial and scientific manufactures by the educational method in question. If that be so, surely no one will grumble at the means adopted to supply the fair promise.

The management of the *Young America* is vested in a company, of which Lieut.-Commander C. H. Harlow, an officer in the United States Navy, is president, and associated with him are several prominent naval and industrial authorities.

It should be added that pupils are enrolled on the roster of the school between the ages of 14 and 19 years inclusive. *Bon voyage.*

XUM

Sunspot Variation in Latitude.

By WILLIAM J. S. LOCKYER, M.A., Ph.D.

FROM a study of the facts regarding the distribution in latitude of spots on the surface of the sun, Mr. Maunder and I evidently hold different opinions, and I do not think that a further discussion of the subject will tend either to change them or advance our knowledge of this spot distribution.

Perhaps I may, however, be permitted to make a final reply to some of Mr. Maunder's remarks in your October issue.

Speaking of the term "spot-activity track," Mr. Maunder says: "It is abundantly clear that he did intend to intimate by it that the spots were gathered together in certain districts or regions, *separated from each other by broad, barren intervals*, and that these districts, rich in spots, moved continuously downwards towards the equator." (The italics are mine.)

I am afraid Mr. Maunder cannot have read my paper thoroughly, or even carefully looked at the figure on page 144.

In the paper I have stated (p. 145), "in this way it was possible to trace the varying positions, as regards changes of latitude, of the *centres of action* or *maxima points of the curves*, from year to year . . ."

And on page 147 the term "spot-activity tracks" is applied "simply to the changes of positions of the regions in which they (the spots) are *most numerous*."

I have nowhere mentioned that these regions were separated from each other by "broad, barren intervals," as he calls them, for such a statement would be against all the facts; if the text and diagrams be consulted, no such general deduction can possibly be made with accuracy.

It was to make this, among other points, clear, that Fig. 1, p. 181, in the August number of this journal was inserted, where it will be seen that the portions of the curves between the individual maxima do not reach down to the zero line, which they should do if those regions were "broad, barren intervals." If Mr. Maunder considers that these "broad, barren intervals" are suggested on the curves marked A in plates 4 and 5 of my paper, then this is another indication that he has not read it carefully before criticising it. In describing these curves to which reference has just been made, I pointed out (p. 146) that they "were proportionally thickened to indicate approximately the relative amount of spotted area *at these centres of action*, or, in other words, the heights of the maxima points on the yearly curves. These curves thus indicate for each year the positions, as regards latitude, of the particular zones in which *the centres of spot-activity* occur."

Mr. Maunder in his letter states further that he "explained therein the nature of the mistake which Dr. Lockyer had made with regard to the maxima on which he based his paper, and that his method of joining them up so as to show apparent lines of drift was not only purely arbitrary, but was often against very distinct and positive evidence."

I am afraid, however, I cannot accept this explanation which he has so gratuitously offered. To my mind the larger the sunspot or its greater extent in latitude, and the longer it exists, the more important becomes the region in which such a disturbance takes place. Mr. Maunder evidently thinks otherwise.

In the note on page 159 of this journal, which from its general tone I assume Mr. Maunder wrote, it is stated that "Mr. Maunder showed that the Greenwich Sunspot Results for the last 30 years fully confirmed Spörer's Law," yet Mr. Maunder now claims priority for a statement I have made which is not in strict accord with this law.

According to Spörer's Law, formulated about 1880, the highest spot latitudes occur about the time of sunspot minimum. In my paper I suggested that this law needed modification because an analysis of the facts indicated that:—

(*a*). Outbursts of spots in high latitudes are not restricted simply to the epochs at or about a sunspot minimum, but occur even up to the time of sunspot *maximum*.

(*b*). The spots tended to reach their highest latitudes at or about sunspot *maximum*.

(*c*). From sunspot maximum until about the following minimum high latitude spots were for the most part conspicuous by their absence.

The above three deductions, all of which can be gathered from an intelligent examination of the plates accompanying my paper, show that the appearance of spots in high latitudes bears a fairly definite relation to the sunspot maxima and minima epochs.

Mr. Maunder refers to a paper (*Monthly Not.* May, 1903) prepared by him by the desire of the Astronomer Royal, in which his deduction as regards the occurrence of high latitude spots is as follows:—

"Taking them as a class by themselves, they were seen irregularly, appearing at times which did not seem to bear any fixed relation to any one of the four chief stages of the sunspot cycle—minimum, increase, maximum, and decline. . . ."

Since Mr. Maunder's "brief preliminary text," to which he refers, suggests an *irregularity* of appearance of high latitude spots, and my statement restricts this time of appearance from about a sunspot minimum to about a sunspot maximum at which the highest latitudes are attained, I fail to see how he can "claim" the priority of the deduction I made.

Mr. Maunder has further forgotten to mention one of the conclusions, corroborating my statement, to which Father Cortie recently arrived, namely:—

"Greater disturbances are most prevalent in high latitudes at or near the times of solar maximum . ." (*Monthly Not.*, Vol. 64, p. 766.)

Would not Father Cortie also have referred to Mr. Maunder's "brief preliminary text" if a statement equivalent to the above had been previously published by Mr. Maunder?

In conclusion I may be permitted to add that it was very far from my thoughts to take the "results" of Mr. Maunder's paper as he states in his last letter. Researches at the Solar Physics Observatory rendered it necessary to make a detailed study of sunspot observations, and use was made, by permission of the Astronomer Royal, of *data* (which at the request of the Solar Physics Observatory had been brought up to date) and not of *results* derived by Mr. Maunder.

It seems necessary to point out to Mr. Maunder that observations are made, collected, and reduced at public expense, in order that they may be studied by those who wish to utilise them for the purposes of science, and are not the "property "of any computer or assistant who may have been charged with the duty of preparing them for publication.

XUM

NOTES.

ASTRONOMICAL.

The Nebulae and the Milky Way.

It is often stated that the nebulæ properly so called—the "white" nebulæ—avoid the galactic region and cluster towards its two poles. It is manifestly so with respect to the north pole of the Galaxy, but Dr. C. Easton, in the *Astronomische Nachrichten* (No. 3969), questions if the same relation holds good for the southern pole. The statistics at our disposal do not bear it out, but this has hitherto been generally explained as due to the insufficiency of observations in the southern hemisphere. Dr. Easton shows that this is not the case; for since the Galaxy is inclined at an angle of 60° to the equator a considerable part of the galactic northern hemisphere lies to the south of the equator, and of its southern hemisphere to the north. Calling the former segment A, the latter B, we have

Faint nebulæ	A	754	B	1043
Bright nebulæ	A	152	B	71

If nebulæ were really distributed on the whole in the same way in the two galactic hemispheres, and if any apparent want of the expected condensation round the south galactic pole were simply due to the insufficiency of observations in the southern hemisphere, then more nebulæ, both bright and faint, should be observed in segment B than in segment A. There is an increase in faint nebulæ, but a most striking falling off in bright. This indicates a great increase in the proportion of faint to bright nebulæ in the galactic southern hemisphere, and it is exceedingly improbable that future observations in the southern hemisphere will discover so large a number of nebulæ round the south galactic pole as to bring it into symmetry with the northern. The distribution in the two hemispheres appears to be different, and Cleveland Abbe's theory of an "ellipsoid of nebulæ," with its major axis at right angles to the galactic plane, seems to accord with this want of symmetry. Dr. Easton, in the concluding portions of his paper, regards the faint nebulosities as allied to the stellar agglomerations of the Milky Way; the nebulæ properly so-called to the sparsely distributed stars of the general stellar system, the non-galactic stars.

* * *

Explanation of the Martian and Lunar Canals.

Professor W. H. Pickering, in *Popular Astronomy*, declines to follow Mr. P. Lowell in his heroic scheme of artificial pumping to account for the flow of water in the Martian canals. He shows that the lunar canals are dotted by small craterlets, and are so symmetrically connected with them as to show a causal connection. He therefore suggests that the canals on the Moon, and by analogy on Mars also, are lines of volcanic action where the crust has been fractured, and that enough water and carbonic acid may escape from the centre craterlet and flow down its sides to develop the vegetation upon its slopes, whilst the smaller quantities escaping from various points along the radiating cracks similarly develop the vegetation along their course, the "lakes" and "canals" as we see them being thus regions of vegetation. On account of the rarity of the atmosphere, the vapours, instead of rising, would immediately spread themselves along the surface of the ground.

The *Monthly Review* for October contains an article on "The Markings on Mars: a Plea for Moderate Views," by Major P. B. Molesworth, R.E. Few astronomers can speak on the subject of Mars with the authority of Major Molesworth, since his studies of the planet have been carried on under exceptionally good observing conditions, with the utmost perseverance, and with great skill in delineation. He concludes that: (1) The markings on the surface of the planet are more or less permanent, but subject to minor changes. (2) Their intensity depends in some way on the Martian seasons. (3) The structure of the delicate detail is the same all over the planet, both in the light and dark areas, the only difference being in the varying tone of the "background." (4) This detail is "the integration of markings far too small to be separately defined."

* * *

The Ninth Satellite of Saturn.

The first visual observation of this object was obtained on August 8 by Professor E. E. Barnard at 18 hrs. 0 min. G.M.T. Its apparent place was R.A. 21 hrs. 23 min. 1·0 secs.; declination, 16° 36′ 8″. On September 3 Professor Barnard found no star was visible in this place. The magnitude of the object was estimated at 15·5 or 16·0. Another observation by Professor Barnard is dated September 12, when the magnitude of the satellite was given as 16·7.

In the number of the *Observatory* for October, Mr. Crommelin gives the result of a rough preliminary examination of the orbit from the very few observations which have yet been published. He finds that the hypothesis of retrograde motion suits the observations as given much better than that of direct motion. This, if established, would be a most extraordinary circumstance, the other eight satellites moving directly. Mr. Crommelin gives the siderial period as 443 days, and the distance 6,960,000 miles, inclination to ecliptic about 6°, to Saturn's orbit about 4½°, to Saturn's equator, 30°. The magnitude given by Professor Barnard, 16·7, would correspond to a diameter of about 120 miles.

* * *

Radiation in the Solar System.

In the course of an address given to the British Association, Professor J. H. Poynting gave in clear and succinct form some of the conclusions which may be drawn from researches in recent years, both on the temperature effects of radiation and the effects due to light pressure. Beginning with Stefan's law, that the stream of energy is proportional to the fourth power of the temperature, reckoned from the absolute zero 273° below freezing point on the Centigrade scale, he quoted, as probably not far from the true value, that the stream of radiation from the sun falling perpendicularly on 1 sq. cm. *outside* the earth's atmosphere would heat 1 gramme of water ¾° C. every second, or would give ¾ calorie per second. Hence he deduced that the mean temperature of the sun's radiating surface is 6000°, if the sun radiates as a body would do which is perfectly black when cool. Further, he gave a table of temperatures at various planetary distances from the sun's centre:—

Distance from the Sun's centre.	Temperature Centigrade.	
At Mercury's distance....	210°	Tin nearly melts.
At Venus's distance.....	85°	Alcohol boils.
At Earth's distance.....	27°	Warm summer day.
At Mars distance	−30°	Arctic cold.
At Neptune's distance ..	−219°	Nitrogen frozen.

Now, the estimated mean temperature of the earth's surface is about 16° C., which is sufficiently near the value given in the table when the radiation from the surface of the atmosphere and other such conditions are taken into account. Professor Poynting then points the moral that, given atmospheric conditions on Mars not very unlike those on the earth (as observation seems to show), even the highest equatorial Martian temperature cannot be much greater than −38°, and "it is hard to believe that he can have polar caps of frozen water melting to liquid in his summer and filling rivers or canals. Unless he is very different from the earth, his whole surface is below the freezing point."

Turning, then, to the effects of light pressure, he gives the total effect on the earth at its present distance from sunlight as 70,000 tons. Since gravitation depends only on the mass and light pressure on the surface area, it follows that were the earth's volume divided up into separate spheres, each $\frac{1}{10000}$ cm. in diameter, the pressure of light would balance the pull of gravitation. If, on the other hand, we diminish the radiating body whilst retaining its high temperature, we find similar effects. If it were possible to reduce the sun to a dia-

meter of 20 miles, whilst keeping its temperature of 6000°, a balance between the pull of gravitation and the push of sunlight would again be held even. If, in addition, we diminish the temperature, Professor Poynting showed that two spheres, each of the density and temperature of the earth, would neither attract nor repel each other when their diameters were about 6·8 cm., if they received no appreciable radiation from the surrounding region. This last result is of importance in relation to the meteoritic theory. Seven centimetres is a large value for the average size of meteorites in a swarm, yet Professor Poynting's research seems to indicate that the tendency of the members of a swarm smaller than these would be to repel each other and scatter, not to attract each other, collide and ignite.

BOTANICAL.

By S. A. Skan.

Professor A. Nestler, whose investigations into the poisonous properties of *Primula obconica* were the subject of a note in "Knowledge" about three years ago, has now published, in the form of a brochure of 46 pages and four plates, a more comprehensive account of his experiments with various species of the genus, undertaken to ascertain which of them are capable of producing skin-irritation, and the origin, properties, and effects of the poison. Injury is caused most commonly by *Primula obconica*, to which species the paper is chiefly devoted; but Professor Nestler has clearly proved that other species are also poisonous, though less virulent. The well-known Chinese primrose (*P. sinensis*), *P. Sieboldii*, and *P. cortusoides*, all three of which belong to Pax's section Sinenses, in common with *P. obconica*, have been tested and proved poisonous. Eleven other species, including *P. officinalis*, *P. farinosa*, and the Auricula (*P. Auricula*), were also tested, and were found to be innocuous. The author shows that the irritation of the skin is caused by the yellowish secretion of the glandular hairs which clothe the underside of the leaves and the flower-stalks. This secretion contains large numbers of variously-shaped, often needle-like, crystals, and its effects on the skin appear to be identical with those of menthol.

* * *

The Welsh poppy (*Meconopsis cambrica*), which is found wild in Wales and some of the western counties of England, is probably the only species of the genus known to many of the readers of "Knowledge." There are, however, several others, some of which, such as *M. nepalensis*, *M. Wallichii*, and *M. heterophylla*, may be met with in English gardens. Altogether about 20 species are known, and they mostly inhabit the high-level regions of Northern India, Western China, and Tibet. The interesting circumstances attending the introduction of another species to cultivation are recorded in a recent number of the "Gardeners' Chronicle." This species, *M. integrifolia*, has for a long time been represented in herbaria, and attracted the attention of Messrs. Veitch, of Chelsea, who dispatched a collector to the Eastern Tibetan frontier with the main object of procuring some seeds. The plant was found growing in great profusion at elevations from 11,000 to 15,500 feet, and was only reached after an arduous journey, during which the travellers suffered more or less from the rarefied atmosphere, from the cold, and from snow-blindness. Its seeds were secured and sent to England, and now its large yellow flowers, which in the wild specimens are sometimes 8 to 10 inches in diameter, have for the first time appeared in our gardens.

* * *

A Bath firm of engineers has recently met with some vegetable matter in the water of the famous King's Bath, of which the temperature is about 120° F. It was found in a shaft through which the water from the hot spring rises and overflows to fill the bath, and proves to be a filamentous Alga known as *Oscillaria thermalis*. Mr. G. S. West has an interesting paper in the "Journal of Botany," 1902, in which he gives an enumeration of species of Algæ found in a collection made in the hot springs of Iceland, with the addition of a few from the Malay Peninsula. In Iceland the highest temperature of the water in which plants were collected was 185° F. The late Professor W. H. Brewer, in a note published in the "American Journal of Science," 1866, XLI., records the presence of living Algæ in the geysers of Pluton Creek, California. In this case the highest temperature of the water found to contain living plants was about 200° F.

ORNITHOLOGICAL.

By W. P. Pycraft.

Red-backed Shrike Breeding in Confinement.

Dr. A. L. Günther, F.R.S., is to be congratulated on having succeeded in breeding the Red-backed Shrike, *Lanius collurio*, in confinement. In the *Avicultural Magazine* for October he gives a long and delightful description of the habits of his birds both before and during this momentous time.

Taken from the nest last year, and reared by hand, they were turned out early this year into a large aviary, affording plenty of cover in the shape of large bushes. Towards the end of May, Dr. Günther first made the discovery that nesting operations were going on by finding a nest in a holly-bush 4 feet from the ground, and containing five eggs. This nest, be it noted, though built by birds which had never known freedom, was in all respects typical of the species.

On June 6, after 14 days' incubation, five young appeared—nearly a month earlier than would be the case with wild birds. Unfortunately, cold weather soon set in, and this proved fatal to the callow young, which died on June 14.

The bereaved birds, however, soon began to pair again. By June 24 the female was sitting on the old nest; on another clutch of five eggs, which, curiously enough, were *more* brilliantly coloured than those of the first clutch. On July 7 four of the eggs had hatched out, the fifth next day. This last nestling was conspicuously smaller than the rest, and died next day; another death occurred on the 11th. By the 23rd two of the three remaining young had left the nest; the third followed next day. But they had evidently started too soon, as the flight feathers were not big enough, and they had to spend the next three days on the ground before they could get back into the bush again.

By August 28 the parents had ceased to feed them, and they are still flourishing.

* * *

Birds of Paradise in England.

No less than five Birds of Paradise are now living in the aviaries of Mrs. Johnstone, a prominent member of the Avicultural Society. Three species are represented—two Kingbirds of Paradise, *Ciccinurus regius*, to be transferred immediately, we are happy to say, to the Gardens of the Zoological Society, two Lesser birds of Birds of Paradise, *Paradisea minor*, and one Great Bird of Paradise, *Paradisea apoda*, and all are in excellent condition.

Never before, probably, has *Ciccinurus regius* been seen alive in Europe. It is therefore to be hoped that they will live long, more especially as they are regarded by many as the most beautiful species of their kind.

* * *

Immigration of Great Snipe.

During the end of September these islands appear to have been visited by considerable numbers of the Great or Solitary Snipe (*Gallinago major*), inasmuch as individual specimens are recorded as having been shot in Shetland on September 20, in Caithness and Dumfriesshire on September 28, and in Coventry on October 1.

Though occurring regularly every year in England, it is regarded as a rare autumnal visitant both in Scotland and Ireland.

The Great Snipe is peculiar in haunting much drier places than the Common Snipe.

XUM

Osprey in Surrey.

During the middle of September one of these magnificent birds took up a temporary residence near the lake at Cranleigh, and, as might have been expected, was shot almost immediately—charged with depredations on rainbow trout which have been introduced there. Since then another of these birds has been seen, and an appeal has been made by Mr. John Bickerdyke, in the columns of the *Field* for October 1, for its protection.

* * *

Aquatic Warbler in Norfolk.

The *Field* (October 8) records the capture on September 15 at Cley, in Norfolk, of an aquatic warbler, *Acrocephalus aquaticus*. This is the seventh occurrence of this bird in Great Britain. The sex of this last specimen is not stated.

* * *

White Waterhen.

The Natural History Museum at South Kensington has just received a very beautiful variation of the Common Waterhen. The bird, which was killed at Stour, Dorset, on October 2, is very nearly entirely white, the red colour of the frontal shield, and the green colour of the legs, forming a very handsome contrast with the snowy plumage. The red colour of the beak and the "garter" round the leg, it is interesting to notice, was very intense, but the green pigmentation of the legs and toes was paler than normal; the claws, indeed, were nearly white.

ZOOLOGICAL.

By R. Lydekker.

The Mammals of Central Asia.

In connection with the article in our September number, on the mammals of Tibet, considerable interest attaches to Dr. W. Leche's account of the large mammals collected by Sven Hedin during his travels in Central Asia between 1899 and 1902, published at Stockholm, in the sixth volume of the "Scientific Results" of that adventurous journey. Perhaps the most interesting conclusion is that the wild camels found in large droves in the deserts of Central Asia are truly wild animals, and not, as has been generally supposed, the descendants of individuals escaped from captivity. From the existence of intermediate forms, the author is led to confirm the view of the present writer that the Tibetan argali is merely a local race of the Siberian animal, and that it should consequently be known as *Ovis ammon hodgsoni*. He also describes a stag which appears to be in some respects intermediate between the Yarkand (*Cervus canadensis*) and the Lhasa stag (*C. albirostris*); and arrives at the conclusion that the two forms of bear mentioned in our article belong to a single species (*Ursus pruinosus*).

* * *

Armoured Cat-Fishes.

An important memoir, by Mr. C. T. Regan, of the British Museum, on a peculiar group of South American freshwater fishes, which may be popularly known as armoured catfishes, has recently been published in the *Transactions* of the Zoological Society. For a long time these fishes were included among the *Siluridæ*, or true cat-fishes, as typified by the wels (*Silurus glanis*) of the rivers of Continental Europe, but are now regarded as forming a family (*Loricariidæ*) by themselves. The majority of the characters by which these fishes can be distinguished from the *Siluridæ* are connected with the skull and skeleton, but the more typical forms may be easily recognised by the armour of overlapping bony plates protecting the body, from which the type genus *Loricaria* takes its name; the inferiorly-placed sucking mouth is also very characteristic. There are, however, certain degenerate types, such as *Arges*, in which the armour has been completely lost. Probably these fishes are derived from the *Siluridæ*, and their recognition of their right to rank as a family adds one more peculiar type to the fauna of Central and South America, which their ancestors may have reached by means of a former land-connection with Africa, and where they range from Panama and Trinidad or Porto Rico to Uruguay. No less than 189 species, arranged in 17 genuine groups, are recognised. It appears that these fishes are in the habit of anchoring themselves to stones in the river-bed by means of the sucker-like mouth; respiration being at such times effected by taking in water through the gill-openings and expelling it again by the same aperture in the opposite direction. Most of the genera are represented in all the South American river-systems, while even some of the species have a very wide geographical distribution.

* * *

"The Paca-rana."

In this column reference has previously been made to Dr. Goeldi's interesting re-discovery of the remarkable Peruvian rodent *Dinomys branichi*, hitherto known only by a single individual captured in 1873. As Dr. Goeldi's paper is now published in the October issue of the Zoological Society's *Proceedings*, a few notes may be added on such an interesting creature. In the first place, it appears that the animal is known to the Tupi Indians, by whom it is called the páca-rána, or false páca, in allusion to the resemblance of its coloration to that of the true páca (*Cælogenys paca*), from which it differs, however, by its well-developed tail and the absence of cheek-pouches. The Tupi name may be adopted as the popular title of the species. Dr. Goeldi states that the páca-rána is a rodent of phlegmatic and gentle disposition, which may account perhaps for its rarity, if, indeed, it be really scarce in its native home, which is probably the eastern slopes and table-lands of the Bolivian and Peruvian foot-hills bordering on Brazil, inclusive of the headwaters of the Purus, Acre, and Jurua rivers. Dr. Goeldi adds that he "shall soon have occasion to show that a scientific exploration of that region will result in a multitude of great surprises both from a zoological and a palæontological point of view, of which the interesting re-discovery of *Dinomys branichi* is only a first instalment."

* * *

The Races of Europe.

In his Huxley Memorial Lecture, delivered on October 7, Dr. Deniker, after referring to Huxley's recognition of two main stocks, the fair Caucasians, or Xanthochroi, and the dark Caucasians, or Melanochroi, in Europe and Asia, expressed the opinion that there are really six well-marked European races of mankind. These are (1) the blonde, wavy-haired, long-headed, long-faced, and tall Northern Race; (2) the Eastern Race, which is also blonde, but has straight hair, a rather short head, and broad face, with a short stature; (3) the Ibero-insular Race, of Spain and Portugal, which is dark, very short, long-headed, with straight or retroussé nose, and sometimes curly hair; (4) the Western Race, dark, round-headed, and short, with round face, broad nose, and thick-set body; (5) the Atlanto-Mediterranean Coast Race, very dark, moderately long-headed, and fairly tall; and (6) the Adriatic Race, from the borders of the Gulf of Venice, which is dark and short-headed, with the nose slender and straight or arched.

* * *

The New Central African Pig.

When Stanley heard of the occurrence in the forest of Central Africa of the animal now known as the okapi, he also saw or received reports of a large species of pig. These reports have proved true, for Mr. R. Meinertzhagen has killed specimens of a wild swine from the eastern side of the great forest, the spoils of which have safely reached the Natural History Museum. Mr. O. Thomas reports that these indicate not only a new species, but likewise a new generic type of wild swine, for which he suggests the name *Hylochœrus meinertzhageni*. The forest hog, as it may be called, apparently comes nearest to the wart-hogs (*Phacochœrus*) of Africa, but has a less specialised type of skull and dentition, and thus serves to connect those hideous creatures with more typical swine. The tusks, although very much smaller, have the characteristic curvature of those of the wart-hog, and there is the same reduction in the number of the upper incisors to a single pair. The coat of black hair is, however, much more profuse than in the wart-hogs. Although the discovery of this new type falls far short of that of the okapi in the matter of interest, yet it is nevertheless one of very considerable zoological importance. Unfortunately, the specimens sent home are too imperfect for mounting. Mr. Thomas's description of the new animal appeared in *Nature* of October 13.

An Electric Influence Experiment.

Interesting Illustration of the Principle of the Wimshurst Machine.

By Charles E. Benham.

The following simple experiments will be found entertaining in themselves, and at the same time they will help to elucidate the principle of the remarkable accumulation of electricity which occurs in the well-known Wimshurst influence machine.

Take four pieces of glass—half-plate negative glass ($6\frac{1}{2}$ by $4\frac{3}{4}$) will do very well—and mount a 3-inch circle of tinfoil on each, a little above the centre, as shown in fig. 1. Coat the glass well on both sides with shellac varnish, which, by the way, should always be filtered through a few thicknesses of fine muslin to ensure a good smooth surface.

Fix two of the glass plates, which we will call A and B, edge to edge horizontally, with the tinfoil downwards, holding them in a vice, or pushing their ends into a grooved block of wood as shown in fig. 2.

Lay the two other plates, C and D, with tinfoil upwards, on the fixed plates, C on A and D on B. The tinfoil not being central, the glass will project beyond the edge of A and B, thus enabling C and D to be handled and moved as required in the experiment.

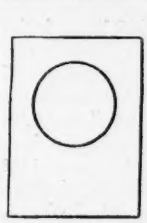

Fig. 1.

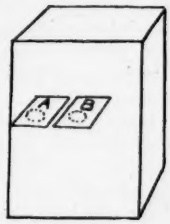

Fig. 2.

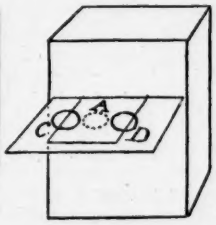

Fig 3.

Touch C and D with the finger and they will receive from A and B respectively an infinitesimal charge of electricity, probably quite imperceptible, even with a delicate electroscope. Remove the finger, and then without displacing C turn D over on to it, so that the two tinfoils of the upper plates are in contact. The surface of C D will now have the combined charges of C and D. Touch A, and it will receive by induction a charge equivalent to this combined charge—still an imperceptible one. Lay the pair on B and touch B, which will likewise receive a similar double charge. Open out the two plates and repeat the whole process. It will be seen on consideration that the second time C and D will receive practically double the charge they first took up. At the third operation they will again double their last charge, and so on. It is not really quite double, but taking the accumulation as being practically in that ratio, it means that in ten operations the original charge will have increased more than a thousand times. At any rate, before the tenth time sparks will probably be observed at each touching of the tinfoils, and will be found to increase every time until the limit of the capacity of the surfaces is reached.

To those who are familiar with the principle of the "doubler," invented by Bennet more than a hundred years ago, there is nothing surprising about this method of producing electricity, but to the tyro, or to persons unacquainted with electric phenomena, this creation of a powerful and increasing series of sparks without any manifest original source cannot fail to seem astonishing.

It is evident that while electricity is produced by this simple process—and with large plates is produced in considerable quantities—it would be mechanically inconvenient to construct an apparatus to go through these intricacies of touching and transposing glass plates, but a further experiment will show how the most troublesome part of the process may be dispensed with, and will at the same time illustrate in a striking manner the very principle of the accumulative power of the Wimshurst machine.

For this second experiment only three of the tinfoil discs are required—A, C, and D—and it will be more convenient if C and D are on one plate. A being fixed as before, lay the larger plate upon it with the tinfoil C (uppermost) over A. Charge C by touching as before. Then slide the upper plate so that D is over A, and, by touching, charge that too. C and D now have between them double the charge of A, but of course a charge of opposite sign. C and D cannot be brought into contact as before, but if the plate is moved so that A is midway between them (as in fig. 3), A will be under the influence of both, and will, when touched, receive a charge by induction, and a repetition of the process will quickly result in accumulation, so that all three discs will soon be strongly charged. On separating them and touching each in turn, strong sparks will be given off by each.

The application of this principle in the Wimshurst machine is at once obvious, though it has never perhaps been illustrated in this way before. Each sector of the Wimshurst, as it passes under the brush, is earthed while under the influence of more than one sector of the other disc, for it is within the field of at least two or three of them. The sector, when earthed by the brush, is, in fact, in the position of A in fig. 3, while the adjacent sectors of the other disc are equivalent to C and D in the above experiment. Each of the four brushes of the neutralising rods places a sector at a similar advantage for increasing its charge, and hence the ready accumulation of the Wimshurst machine.

After this it also becomes evident why a certain number of sectors are advisable for the Wimshurst machine. It will, indeed, act without any sectors at all, but only while the brushes are new and very large, their ends that touch the glass taking the place of the tinfoil. But in practice, the inventor of the Wimshurst machine recommended that there should never be less than a certain number of sectors, the minimum depending on the size of the plate. The reason for this minimum would appear to be, in the light of the experiments described above, that with widely separated sectors the carriers would not be within the field of more than one at a time, in which case the multiplication of the charge would not take place. On the other hand, sectors can be too numerous. This is not only because of the leakage involved, but also because the carrier (represented by A in our experiment) would then be under the inductive influence, not only of the sectors of the other disc, but also of those to right and left of it on its own disc, which sectors are charged with electricity of sign similar to its own, and tend therefore to neutralise the inductive effect of those on the other disc, which are of opposite sign.

Gluttonous Animals.

By R. Lydekker.

Many kinds of carnivorous animals, such as the larger members of the cat tribe, are in the habit of periodically eating very heavy meals, and then abstaining altogether from food for several days, until the pangs of hunger once more reassert themselves. Pythons and certain other snakes come under the same category, as does also the common or medicinal leech. Such animals clearly are not to be classed as gluttonous—they might almost as well be included among fasting animals—they merely take in large supplies of food at long intervals, and, on the average, do not appear to devour more than a normal amount of nutriment. Vultures, on the other hand, although they likewise require a period of abstention from food of some length after each gorge, do appear to consume very much more than an average quantity of food, and, therefore, strictly speaking, come within the scope of the present article.

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The animals to which more particular reference is intended are, however, such as are in the constant habit of consuming abnormally large supplies of food without taking intervals of unusual length between their meals. Among wild animals such instances are rare, but are more common among carnivorous than among herbivorous or frugivorous types. Indeed, among purely herbivorous animals, there does not seem to be a single species, either wild or tame, which deserves to be called a glutton. It is true that sheep and cattle, when suddenly turned into a field of green wheat or other succulent herbage, will often eat such a quantity as to be in danger of suffocation unless operated upon with the trocar; but in this case the evil results are largely due to the nature of the fodder, which, during the process of digestion, develops a quantity of highly expansile gases, rather than to absolute gluttony on the part of the animals themselves. Not but what domestication has a tendency towards the development of greedy and gluttonous habits, as witness the familiar cases of the pig and the duck, the wild ancestors of which are among the most active animals, and display no tendency to overeat themselves.

Be the exact position in the present category of the above-mentioned wild creatures what it may, there can be no doubt that, as indicated by the first of its popular names, the glutton, or wolverine (*Gulo luscus*) is entitled to a very prominent position among greedy animals. Not but what, as is almost universally the case in analogous instances, the creature's propensities in this direction were considerably exaggerated by the older writers. We may dismiss, for instance, as pure fable the old story that when one of these creatures had indulged in an extra big gorge it was in the habit of squeezing itself between the stems of two fir trees growing close together in order to get rid of its meal. Nevertheless, modern testimony is to the effect that the glutton thoroughly deserves its name, and that its eating powers are well-nigh, if not altogether, unequalled by its compeers in size. It is, however, very difficult to find anything like accurate data on this point, or, indeed, a statement as to the weight of the creature. Here occasion may be taken to refer to the deficiencies of natural history works in regard to the weight of animals. For instance, in three well-known manuals of British mammals no mention is made of the weight of the badger, which might serve as a basis for an estimate of that of the glutton. Roughly speaking, the latter weight may, however, be estimated at between 35 and 45 pounds. Now as regards the amount of meat a glutton has been known to eat, the only definite statement within the writer's knowledge is to the effect that one of these animals consumed 13 pounds at a "sitting," or, at all events, in a single day. And since in a wild state the creature's appetite would probably be sharper, it can scarcely be an exaggeration to say that a glutton can eat about a third of its own weight in a day. It is true that this is nothing like the proportion of food to weight that has been recorded in certain smaller creatures to be noticed later on, but then small animals have very frequently much greater functional activity than larger ones, as witness the muscular power of an ant or a grasshopper compared to that of man. Nevertheless, 13 pounds of solid meat is a good record for a creature of the size of a glutton, which is about half as big again as a badger.

Not only is its appetite wonderfully good, but the glutton displays extraordinary acuteness and perseverance in getting at stores of concealed food; somewhat tainted carcases forming its favourite *bonne-bouche*. In the forest districts of Arctic North America, which, in common with similar latitudes in the old world, form the home of the glutton, the hunters are in the habit of concealing the carcases of their quarry in *caches* for future use; and from such depositaries it is almost impossible to keep out the wolverine, which has been known to gnaw through a solid log of timber in order to obtain access to the dainty. When access is gained, the creature will gorge itself to satiety, and, what is more, will shortly after return for another and yet another meal, until the supply is finished; for the glutton, unlike the larger cats, does not apparently stand in need of a protracted fast after a carouse, but has scarcely finished one meal when it is ready for another.

Most of my readers, it may be presumed, are acquainted with the wolverine at least by its fur, which is now largely used for carriage-rugs, samples of which may be seen in the furriers' shops, where a stuffed specimen of the entire animal is also sometimes exhibited. Indeed, the specimen now exhibited in the Natural History Museum was bought ready stuffed from Messrs. Shoolbred. Somewhat badger-like in general appearance, but with a bushy tail of medium size, the wolverine has beautiful long silky hair of blackish brown colour relieved by a broad ellipse of golden tawny.

Our next example of gluttony is afforded by a fruit-eating bat, one of the group commonly known as flying-foxes; the species in question being a native of India and the Indo-Malay countries as far eastward as the Philippines, and technically known as *Cynopterus marginatus*. From its gluttonous habits, this bat is a great scourge to fruit-growers in the East; the extent of its eating powers may be gathered from the following anecdote recorded by the late Dr. G. E. Dobson, in his time the great authority on bats of all kinds:—

"To a specimen of this bat obtained by me at Calcutta, uninjured," writes this author, "I gave a ripe banana, which, with the skin removed, weighed exactly two ounces. The animal immediately, as if famished with hunger, fell upon the fruit, seizing it between the thumbs and the index fingers, and took large mouthfuls out of it, opening the mouth to its fullest extent with extreme voracity. In the space of three hours the whole fruit was consumed. Next morning the bat was killed, and found to weigh one ounce, half the weight of the food eaten in three hours. Indeed, the animal, when eating, seemed to be a kind of living mill, the food passing from it almost as fast as devoured, and apparently unaltered, eating being performed alone for the sake of the pleasure of eating. This will give some idea of the amount of destruction these bats are capable of producing among ripe fruits."

A close race with this bat in respect to the amount of food devoured is run by the common mole, which is one of the most greedy of all mammals, and will, it is said, perish of hunger and exhaustion if kept without food for a few hours. Indeed, when we remember that the mole feeds exclusively on animal substances, which are much more highly nutritive than those of a vegetable nature, and that it thoroughly digests its food, it seems highly probable that the mole, in respect of gluttony, altogether beats the bat.

Whenever a mole is killed, its stomach is almost sure to be found crammed full of worms, some of which show every appearance of having been swallowed whole. The only record presenting any ap-

proach to a definite estimate of the amount of food a mole will consume in a given time appears, however, to be one furnished a good many years ago by the late Mr. E. R. Alston, an accurate student and observer of British and other mammals. According to this statement, a mole kept in captivity devoured in the course of a single day an amount of food estimated to considerably exceed its own weight. During the first three days of its captivity it consumed three or four dozen earth-worms, a large frog, a quantity of raw beef, the body of a turkey-poult, and part of that of a second, as well as one or two black beetles. It is, of course, a great pity that an accurate record of the weight of the food thus devoured was not kept, but it is quite evident that it was enormous in proportion to the size of the animal by whom it was eaten. And the marvel of it all is that the mole, like the aforesaid fruit-bat, does not appear to become "stodged" after meals of this description, but in a very short time is perfectly prepared—nay anxious—to commence afresh.

Our last instance of voracity in mammals is taken from the cetacean group, and it is of so extraordinary a nature that, were it not attested by a naturalist of high and unimpeachable authority, it would appear absolutely incredible. The species to which the anecdote relates is the so-called killer-whale, or grampus (*Orca gladiator*), a highly carnivorous and formidably-armed creature, black and white in colour, and conspicuous on account of its tall dorsal fin when swimming near the surface. It is a by no means infrequent visitor to our coasts, and is the only cetacean that habitually preys upon warm-blooded animals. In length it varies between about 16 and 25 feet or rather more. No statement as to its weight has apparently ever been published, but, as a very rough estimate, this may be set down as about four or five tons. According to the well-known Danish naturalist, the late Professor Eschricht, one of these killers is known to have swallowed four whole porpoises in succession; while from the stomach of a second, about 21 feet in length, were taken the remains of no less than 13 porpoises and 14 seals in a more less digested condition; the brute having been apparently choked by the skin of another seal, parts of which were found clinging to its teeth. In quoting the latter half of Professor Eschricht's statement, some writers (notably Mr. F. E. Beddard, in his "Book of Whales") omit all reference to the more or less digested condition of the seals and porpoises, so that it reads as though 14 entire specimens of the former and 13 of the latter were extracted from the creature's interior, which would be a manifest impossibility. As it is, the statement that four porpoises were swallowed in succession is difficult enough to credit, seeing that a full-grown specimen of these cetaceans measures about five feet in length. There can, however, be no doubt that the killer is an unrivalled glutton among the larger mammals.

As regards birds, two or three instances must suffice. The common cormorant (*Phalacrocorax carbo*) is the very type of gluttony, and when gorged, these birds, it is said, will not infrequently continue fishing, although too full to swallow another fish. After a full meal, cormorants may frequently be seen sitting motionless on a rock for hours, with their wings half extended, as if "hung out to dry." Soon, however, they recover their appetite, and begin to renew their pursuit of prey. The amount of fish a cormorant will destroy during a season must be enormous, and there can be no doubt that the numbers in which these birds exist on some parts of our coasts forms a very serious detriment to the fishing interest.

Pelicans are likewise extremely gluttonous birds, as are also the great adjutant storks of India, which, till some years ago, formed such valuable scavengers in Calcutta during a considerable part of the year, where they might often be seen standing stolidly on the *maidan* in a more or less completely gorged state. It used to be commonly said in Calcutta that an adjutant would swallow even so large a mouthful as a dead cat at a single gulp, and there is every reason for believing that the statement is founded on fact.

Many instances of gluttony might doubtless be found among the lower animals, and cases of the crocodile and the common pike might be cited among such; but to do this would entail a considerable amount of space without any real increase in our knowledge, beyond that which is conveyed in the foregoing instances.

What the special object of the development of gluttonous habits in certain particular kinds of animals may be is very difficult to conjecture. In the case of the mole, which is a very active animal belonging to an aberrant and specialised group, it is quite easy to understand why an unusually liberal diet may be essential; the difficulty comes in with regard to creatures like the glutton, which differ in no essential features from many of their relatives, who are content with a commissariat of a more moderate type.

The Coloration of Nestling Birds.

By W. P. Pycraft, A.L.S., F.Z.S., &c.

Part I.

In the pages of "Knowledge" for last year, some may remember, I propounded a theory to account for the differences which obtain between the young of nestling birds in the matter of their activity at the time of their escape from the egg. I propose now to follow this up with a few suggestions as to the probable significance of the coloration of nestling birds.

This subject falls under two different heads: (α) the coloration of the body as a whole; and (β) the coloration of definite regions of the body. Under the first section we have all those birds which are nidifugous, or active from the moment they leave the shell, and some nidicolous or helpless birds. These all agree in that they are downy, but they present different types of coloration, all of which, however, belong to the protective resemblance group. Under the second we have some of the downy forms, and those nidicolous or helpless types, which, though generally coming into the world blind, naked, and helpless, yet frequently exhibit brilliantly coloured markings, generally confined to the mouth. These coloured areas belong to another category, and will be discussed in a future paper.

The down-clad nestling, there can be no doubt, represents the more primitive condition, but it is not so easy to determine whether in any case the primitive type of coloration has also been retained, or whether

what appear to be instances of primitive coloration are really cases of adaptation to environment independently acquired.

That the dominant type of coloration among primitive animals took the form of longitudinal stripes seems to be a very wide-spread belief. These stripes are next supposed to have given way to spots, and these latter either became re-arranged to form transverse stripes, or mottlings, or disappeared altogether, leaving a perfectly uniform coloration unrelieved by any markings, or at least any very conspicuous markings such as form a pattern. This orderly sequence seems to imply that these patterns have followed a preordained line of evolution; and that whatever the cause of their origin may have been, the later phases arising therefrom develop independently of the environment. This is by no means a generally accepted view.

Eimer supposes "that the fact of the original prevalence of longitudinal striping might be connected with the original predominance of the monocotyledonous plants, whose linear organs and linear shadows would have corresponded with the linear stripes of the animals; and further that the conversion of the striping into a spot-marking might be connected with the development of a vegetation which cast spotted shadows. It is a fact that several indications exist that in earlier periods the animal kingdom contained many more striped forms than is the case to-day." "This supposition," he goes on to say, "is also supported somewhat by the fact 'that at present strongly spotted forms mostly occur in places with spotted shadows, the longitudinally striped more in grassy regions. . . . Cross-marking is perhaps to be connected with the shadows, for example, of the branches of woody plants—thus the marking of the wild cat escapes notice among the branches of trees.'"

That these several types of markings are, in many cases, direct survivals enjoying a transient existence, like many other vestigial characters, is highly probable, but in others they, with almost equal certainty, represent comparatively recent developments.

Thus the spots in the young lion and the faint traces thereof in the adult female are almost certainly remnants of an earlier and more emphatically spotted phase common to the adults of both sexes. But it is surely possible that in many cases these markings may be remnants of an earlier spotted *immature* stage when the young derived benefit from the protection these markings afforded. In such cases the adults may have been quite differently coloured?

The possibility that the coloration may, in the ancestral forms, have been of one type for the *adult* and another for the *immature* stages, and that the ancestral *immature* stages may be reproduced at the corresponding period of development to-day, is one that seems not to have received fair consideration. Evidence in favour of this view will be submitted presently.

According to the prevailing opinion, we have something like a recapitulation of past types of coloration, the markings of ancestral adult stages being reproduced in the immature stages of to-day. On this assumption we must suppose either that this immature coloration is now of no protective value, or that the descendants of these spotted or striped forms, as the case may be, require the ancestral adult protective colours only during the period of immaturity; or that this coloration belongs to the class of correlated variations and has no significance in a large number of cases.

But even this view cannot be reconciled with Eimer's intrepretation of the significance of these markings. If longitudinal stripes are the result of adaptations to foliage of monocotyledonous plants, and spot marking to an adaptation to foliage of vegetation which cast spotted shadows, then the longitudinal markings of many animals of to-day must be quite out of harmony with their environment, and their survival shows that in these cases at least the correspondence between the markings and the type of foliage need not be a very close one, since the longitudinal stripes developed to harmonize with linear foliage serves equally well amid foliage which casts spotted shadows.

Transverse stripes, at least, it must be admitted, owe their origin to adaptation to totally different environments. Originally developed for the sake of affording protection amid linear foliage, as in the tiger, for instance, they have almost certainly been acquired *de novo* in the case of the zebra, where they serve to protect the animal on account of the *absence* of foliage of any sort.

The contention that longitudinal striping was developed in response to linear foliage is lacking in cogency. Vertical stripes would have served the purpose better, supposing that the direction of the stripes was a matter of prime importance. The widespread occurrence of longitudinal stripes probably depends on a deeper stimulus.

The definite and orderly sequence of colour, which many animals exhibit in the course of development, seems to show that in many cases the markings of the immature stages are really reproductions of an ancestral adult livery. This is well seen in cases where the male and female have a distinct livery. Here the females and young are often precisely similar in dress, and bear a remarkably close resemblance to the adult stages of both sexes of more primitive but closely allied species. Among birds there are many illustrations of this. A large number of animals, however, afford no clue as to whether the colour of the immature individual is ancestral or newly acquired; whether it is an ancestral *adult* or an ancestral *juvenile* coloration. The larval Alpine Newt, for example, is conspicuously longitudinally striped. Even while still within the egg these markings can be seen. There is a median dorsal black stripe which bifurcates on the head, and a lateral stripe, also black. Later, black pigment cells wander into the transparent ground colour, and eventually the black upper and red under surface of the adult is acquired. The stripes of caterpillars are not easily accounted for. Are these independently acquired markings, or inherited ancestral *larval* markings? They certainly can have nothing to do with the adult coloration.

With the birds the problem becomes still more complex, inasmuch as, in the precocious types at least, we may have three separate plumages: (*a*) the nestling; (*b*) of the fully-fledged "immature" stage, which may be the same as that of the female; and (*c*) the adult stage, *i.e.*, the plumage worn by the male only, or by both sexes.

With regard to the "immature" stage it is worthy of comment that, as Prof. Newton has pointed out, "Throughout the class *Avis* it is observable that the young, when first fledged, generally assume a spotted plumage of a peculiar character—nearly each of the body-feathers having a light-coloured spot at its tip—and this is particularly to be remarked in many groups

of the oscines. . . ." Concerning this fact, which appears to have been first indicated by Blyth half a century ago, we may have more to say on another occasion. Just now we desire to draw especial attention to the plumage of the nestling, which does not appear to have previously occasioned comment.

There seems to be strong presumptive evidence to show that the primitive coloration of young birds took the form of longitudinal stripes. Nowhere are these stripes seen to better perfection than in the young of the Emu. Here, in the very young bird, we find a long, thin, white stripe extending from the head down the back of the neck, and tailwards along the back on either side of the middle line. Below the trunk-stripe a second occurs, but towards the end of the nestling period it is interesting to notice these stripes appear to increase in number. The second, inferior trunk-stripe of the newly-hatched bird now extends forward to join the neck-stripe just described; and beneath the second, now elongated stripe, a third appears, and this runs upwards to form a second

Fig. 1.—The nestling of the Mooruk Cassowary (*Casuarius burnetti*), **showing strongly marked longitudinal white stripes on a dark chestnut background. Only faint traces of stripes are present on the neck, but in the Emu they are very conspicuous.**

neck-stripe, running parallel with the first; below this third a fourth stripe appears; this extends from the end of the tibia, upwards and forwards along the flanks, terminating at the base of the neck. The continuous neck-stripe, No. 1, breaks up at the base of the skull into a number of dots in this older bird. In the very early stages the legs bear curious mottled markings, but these rapidly vanish.

In the young Cassowary (Fig. 1), at an age roughly corresponding to the second stage of the Emu, only the faintest traces of spots on the head and neck are traceable. On the trunk we find five white bands sharply defined and set off by a darker ground than in the Emu. The fifth corresponds to the leg and flank stripe of the Emu, but is shorter.

In the nestling Rhea stripes also occur, but these are less conspicuous and fewer in number than those of the genera just described. The neck-stripes are obsolete.

The nestling Ostrich appears to differ from the other "Ratites" in having a uniform coloration. The trunk, it will be remembered, presents a curiously grizzled appearance, and this is due to the fact that the tips of the rami of each down feather are produced into long ribbon-like horny processes. But there can be little doubt but that this peculiar structural modification of the down feathers is comparatively recent, since, though these no longer display a pattern, the down feathers of the neck agree precisely with those of the Emu, in that they are coloured so as to form very strongly-marked longitudinal stripes down the back of the neck, while along the front of the neck and the sides of the head these stripes give place to rows of dots.

Apteryx, it may be mentioned, has a uniform grey coloration.

There is no reason to believe that the Grebes are even remotely related to the Ostriches, yet the nestlings of these birds display a precisely similar style of coloration—light longitudinal stripes on a dark ground (Fig. 2).

It is interesting to note that while in the nestling plumage of the "Ratite" birds and the Grebes we find a relatively large number of stripes, in all the forms now to be considered the pattern is almost invariably formed by a median and two lateral stripes.

Fig. 2.—The nestling of the Great Crested Grebe (*Podicipes cristatus*). **The neck stripes are here strongly marked, as in the Emu.**

In some species these stripes are strongly marked, in others barely traceable.

But great variability in this matter obtains, even among the several species of a single family. In the Tinamous, for example, a median stripe along the back, extending forwards up the neck on to the head, and a dark stripe behind the eye, occurs with some frequency. Other of this group are uniformly coloured, or have a dark occipital patch (*Nothocercus*). In *Rhynchotus* the head and neck are spotted, as in the nestlings of the Ostriches.

The game-birds are undoubtedly, as a group, striped when nestlings, though in many this striping is giving way to mottling by the breaking up of the stripes.

The nestling Curassow, *e.g.*, *Crax alector*, is conspicuously banded. The mid-dorsal line is marked with a broad dark chestnut band, tended on either side by a conspicuous white stripe; the band commencing on the head, and widening backwards. The white bars also commence on the head. Again, in the young Argus Pheasant we have a similar dark median band bounded by white stripes. In the young Blackcock (*Lyrurus tetrix*) the general ground colour is buff,

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the back of the neck bears a median stripe which bifurcates at the trunk to run down on either side of the middle line in the form of two indistinct lines. The occiput and the rump are of a warm chestnut colour. But the general effect of this pattern is mottled rather than striped. This mottling is more pronounced in the Capercailzie nestlings, and in those of the Pheasant and Partridge; probably this mottling is derived from the breaking up of stripes; the last phase of the striped dress being seen in the nestling Red Grouse.

The nestling stages of the Chardriiformes, or at least the Limicolæ and Lari, appear to have been originally striped. To-day these stripes are most apparent in the Redshank, Woodcock, and Norfolk Plover (*Œdienemus crepitans*). In the Redshank we find a narrow median dorsal stripe extending forwards up the neck and bifurcating on the crown of the head. On either side of the median stripe are three lateral stripes—these stripes are dark on a buff ground. In the Woodcock the median stripe takes the form of a broad chestnut band. The lateral stripes are wanting.

Fig. 3.—The nestling of the Common Snipe (*Gallinago cœlestis*). There is a second nestling between that in the foreground and the adult. Note how the stripes in the adult harmonize with the ribbon-like leaves of the grass.

The Snipe, however (Fig. 3), is distinctly striped. In *Gallinago cœlestis* (the Common Snipe), for example, the general colour of the down is of a rich dark chestnut, relieved by three very distinct white stripes. The adult is also, it may be remarked, longitudinally striped. The Norfolk Plover has the ground colour of the body of a pale yellowish grey, relieved by two narrow black bars or lines along the back, and a black stripe through the wing and down the middle of the head.

In the other Plovers the stripes have broken up to form mottlings as in the Gulls. But the general coloration is obviously adaptive—procryptic. Thus, in the Knot—which breeds in the snow—the down is white, mottled with grey; the young Kentish Plover has the upper parts very pale buff, powdered with black; and so on. The under parts, as in the case of nearly *all* nestlings, are either pure white or nearly so. The Jacana bears strongly-defined narrow black stripes on a bright chestnut ground.

The Gulls, like the Plovers, show both striped and mottled forms, the former being rare. Indeed, so far, the only striped form I have come across is the nestling of the Little Tern. The ground colour in this species is pale relieved by a median and two lateral stripes. From this we pass to the mottled type, and in many cases, *e.g.*, Common Gull, the median and lateral stripes are still plainly visible; the neck, too, is spotted just as in the young of Dromæus, also indicating the derivation of the spots from stripes. The young Sooty Tern is almost unicoloured, powdered with minute white points; and from this we pass to the completely unicoloured and dark young of the Skuas. The Skuas, it is to be noted, are of a uniform dusky colour.

The Gruiformes would appear to have been originally striped, inasmuch as traces of a broad median band are visible in the young Japanese Crane, while the young Bustard (*Otis tarda*) bears a close resemblance to the young Gull, being pale-coloured with dark mottlings.

The young of the Turnices are striped.

The nestling Rails at the present day are all dusky in colour, yet the young of the Black-tailed Water-Hen (*Microtribonyx ventralis*) shows distinct traces of a median and two lateral stripes.

The Anseriformes, like the Rails, have now typically uniformly coloured nestlings. As a rule the upper parts are dark, the central light. But the young of the Mallard and its near allies have their upper parts relieved by light-coloured spots—one over the thigh and one behind the wing. In many Anatidæ there is a strongly-marked superciliary streak, and a streak passing from the lores to the eye, and behind this to the base of the skull. These markings appear to be remnants of an earlier striped condition. The Sheldrakes depart from this type, having a broad dark median band which passes upwards along the neck and invests the whole of the upper part of the head. A dark patch behind the wing gives the semblance of a white streak on either side of this median band. In the Variegated Sheldrake (*Casarca variegata*) the dark median band expands over the shoulders to form a transverse band. Whether this peculiar coloration of the downy Sheldrake is a modification of an earlier striped condition or a specialised condition it is not easy to say, but it seems probable that the latter is the case. The under parts, as in all the other Ducks, are white. The downy young of Swans and Geese, and of Chauna display no markings, and are either pale grey, or pale yellow in colour.

We come now to a number of groups in which the young appear to be invariably uniformly coloured. But, it is to be noted, these young are all nidicolous—born blind and helpless; and it may well be that these have long since lost the ancestral striping. Many are reared in holes, and in those which lay in open nests the striped pattern of the down would probably afford no protection.

The Steganopodes (Gannets, Tropic-birds, Frigate-birds, etc.) have the young clothed in white down.

In the Ciconiæ (Storks) the young may be thickly clothed with long white down, or thinly clad in long thread-like down feathers, *e.g.*, Herons.

In the Tubinares (Petrels) the down is either white (Albatross) or dusky (Petrels). In the Sphenisci (Penguins) it is dark grey or tawny yellow. In the Colymbi (Divers) dark grey. In the Accipitres it is white or grey. In the Striges and other Coraciiformes the down, when present, is either white or grey in colour.

Among the birds, as in other vertebrate groups, longitudinal stripes do not necessarily give place to a

spotted livery, and this to a uniform coloration. In the nestlings of the Emu, Cassowary, and Grebe, for example, the striped dress gives place to one without markings, and this again to a patternless plumage in the adult stage. The Game-birds furnish us with two very interesting stages of development. In some, *e.g.*, Quails, the young are striped; the first pennaceous plumage—as distinct from the downy plumage—may be described as a brown or buff colour relieved by various shades of darker brown arranged in the form of streaks, spots, and bars. The adult plumage for both sexes is similar. In others, *e.g.*, many Pheasants, the striped downy plumage is succeeded by a dress resembling the immature and adult dress of the Quails. This dress is retained by the female, but in the male is succeeded by a more or less resplendent livery. In other Pheasants, *e.g.*, Eared Pheasants (*Crossoptilon*), the speckled dress of immaturity is discarded by both sexes for one of more or less brilliancy.

The same order of coloration, which obtains in the life of the individual in one group, is found in another group only in studying the history of the race. This may appear to be only another way of saying that the history of the species is a recapitulation of the history of the race. But in the present connection, it is to be noted, the most primitive species passes through all the possible phases in the course of its growth, while the "race" to which we have referred is of comparatively recent origin—the Limicolæ to wit. Herein we find striped forms like the Redshank, or the Snipe, mottled forms like the Gulls and Terns and some Plovers, and unicoloured dusky forms like the Skuas and Alcidæ, *e.g.*, Guillemots. In the Terns and Gulls the mottled nestling gives place to a brown first plumage, which is succeeded by a more or less unicoloured adult dress worn by both sexes alike.

Longitudinal markings occur but rarely among adult birds. Instances thereof are seen in the Snipe, Avocet, Black-throated Diver, Herons, and Bitterns. Now it is worthy of note that in the Snipe and the Bitterns, at least, these peculiar markings are known to be used for protective purposes. The Bitterns when desiring to conceal themselves adopt a perfectly vertical position, throwing the head and neck upwards and holding the body perfectly still so that the dark lines down the neck harmonise with the dark inter-spaces between the reeds which form its cover. The Snipe reverses this position, holding the head downwards and presenting the longitudinally-marked back so that the tail points directly upwards.

From the Ætiological side it must be admitted we have much yet to learn in the matter of these stripes.

Where both nestling and adult wear a protective plumage, it seems strange that in many cases a distinct livery should be necessary for each stage. But this may be due to the fact that the environment of the nestling is quite different to the normal environment of the adult. The downy young Ringed Plover, for example (*Ægialitis hiaticula*), is almost white with dark mottlings; the adult is buff-coloured above, white below, and barred across the head and breast with black. These bars are apparently protective devices, for while the kahki-coloured body is invisible, the dark bars are conspicuous, but they bear a curious resemblance to mussels, the empty shells of which occur on every tide-wash, where these birds commonly feed.

But there is no need to expect a very close connection between the two stages in the life-history, for while in many cases the stripes of the downy plumage may well be ancestral, and, therefore, of extreme antiquity, the plumage of the species is necessarily of more recent origin, and is determined by the requirements of the environment amid which it has developed.

Finally, we are brought to the question of the origin of the stripes. Their remarkably wide-spread occurrence among vertebrates suggests that they must be due in the first place to some deep-seated physiological activities, which determined the deposition of pigment in certain definite areas, serving either as centres of distribution or as screens for the protection of sensitive regions from excessive light. The reasonableness of this latter view is supported by the fact that these stripes occur with striking frequency in "larval" forms, such as of fish and tailed Amphibia, where the bands of pigment over-run the brain, spinal cord, and lateral line organs. Their occurrence in higher vertebrates would seem to decidedly weaken this hypothesis; but it may be that the ancient fashion of laying down pigment is for some reason or other adhered to in these groups, just as gill arches, no longer useful, are also developed.

It seems hardly likely that these stripes in the case of the birds have been independently acquired, and acquired afresh, too, in each group, at least, in which they occur, solely in response to the need for a protective livery of this particular type. But the adoption of this livery as a method of salvation ready to hand seems probable enough.

The existence of whole-coloured forms seems to have been due either (*a*) to the suppression of the stripes in favour of a yet more protective dusky livery, as in the case of the young Waterhen (p. 274), where they are just traceable, or of the grizzled covering of the young Ostrich—which retains the original neck-stripes lost in the Cassowary and Rhea—or (*β*) to the suppression of pigment to secure a white covering, as in the case of birds which, being nidicolous, lie helplessly exposed in open nests to the glare of the noonday sun, and thereby derive benefit from a white covering. That there is some probability in this suggestion is shown by the fact that the Common Buzzard has contracted a habit of erecting a shelter of green boughs above its nest, replacing these as soon as the leaves wither.

The question is full of interest, and demands further study.

REVIEWS OF BOOKS.

Scientific Fact and Metaphysical Reality.—It has lately been remarked that in the disturbance of existing theories which has been produced by the determination of new facts in physical science, there are few hypotheses which seem totally unworthy of consideration, and few speculations that are not valid. One might note as an accompanying phenomenon, that the scientific world seems to have been stirred at the same time by a desire to investigate, not the relations of matter and energy alone, but of mind and energy, and to formulate in as exact a manner as its knowledge will allow the relation of mankind to its own fate and destiny. Some such design is apparent in both of two books, of widely different scope, which are before us—"Scientific Fact and Metaphysical Reality," by Robert Brandon Arnold (Macmillan), and "Ideals of Science and Faith" (George Allen) in which the Rev. J. E. Hand collects the essays of writers who approach the problems of man's life or immortality from such widely different standpoints as those that we expect to be assured by a physicist like Sir Oliver Lodge, a biologist like Professor J. Arthur Thomson, a psychologist such as Professor Muirhead, or educationists, theologians, or divines like Professor Geddes, the Rev. John Kelman, the Rev. Ronald Bayne, or Mr. Wilfrid Ward. The value of such opinions, and of such an assem-

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blage of opinion, lies in its power to induce people, whose views are as wide as the poles asunder on spiritual matters, to lend an ear to that which other people are thinking. There are many people, sane, high-minded, and cultured, to whom the opinions expressed by Sir Oliver Lodge on the scheme of creation will seem as heretical as any that ever sent a man to the faggot and fire; and there are others, not less kindly, conscientious, or tolerant, to whom the reading given by clergymen of the importance of religious tenets must seem illogical to the verge of puerility. There are beyond these two classes of people—like rays in the *ultra*-violet or the *infra*-red—other thinkers who genuinely believe that it is wrong to teach what they call superstition; and other, and equally worthy people who regard doubt of the Old Testament as blasphemy. If the prospect of seeing their own views stated induces any member of any of these classes of people to buy this book, it will probably lead him to read the opinions that are stated side by side with them; and that is all to the good. In this sense Mr. Hand's collection has a great educational value, and of its interest there can be no doubt.

The other book which we have joined to his for the purposes of this review, "Scientific Fact and Metaphysical Reality," is of a different kind, and demands a different kind of intellectual equipment for its appreciation. It is, as we take it, an attempt to state, if not to reconcile, some of the eternal differences which are to be recognised between man's conception of the material universe and the instinctive denial of his own insignificance in it. "The stars . . . by their double scale, so small to the eye, so vast to the imagination, seem to set before man the double nature of his character and fate," wrote R. L. Stevenson. Mr. R. B. Arnold endeavours to disentangle the paradox of man as a mere collocation of living cells; and of man created by God for immortality as he has believed himself to be. Mr. Balfour, in his recent Presidential Address to the British Association at Cambridge, sought to exhibit the contradiction between the physicist's theory that motion was matter, and man's instinctive disbelief—something akin to Nature's abhorrence of a vacuum—in anything which should persuade him that matter was a mere state of motion; that—

> The stately palaces, the solemn temples,
> The round world . . .

could dissolve like the baseless fabric of a vision, and leave not a wrack behind. Mr. Arnold's intention is not to exhibit the paradox, but to reconcile its antitheses; to show, in short, that there may be a scientific reason, not for the grudging admission of the possibility of a superior Being's existence, but for the acknowledgment of a Divine purpose and a Divine future for man's soul. We are not sure whether Mr. Balfour's paradox was sounder than most paradoxes, since the very latest theory of the physicists is, after all, but a tentatively built model of the universe which is of the most temporary value. Theories are only to explain things we do not understand. They are not immortal truths. And if Larmor's and Thomson's and Lodge's modern cosmogonies are only temporary structures, we are not very sure of the value of anyone's theories of God and immortality. But the theories are always interesting, and Mr. Arnold's exposition and his philosophy are exceptionally so.

The Science and Practice of Photography.—By Chapman Jones, F.I.C., F.C.S., F.R.P.S. Fourth edition. Rewritten and enlarged (London: Iliffe and Sons).—The new edition of this well-known text-book is in many respects better than the earlier editions. It has been not merely brought up to date, but re-written, so that, although it is arranged on the same general lines as before, it is practically a new book. Of those parts that are obviously new, we notice especially the chapters on the modern organic developers, the nature of their constitution, and the methods of their use; the most recent lenses and the principles involved in their construction; the nature of the developable image; the newer printing methods, such as the Velours-Artigue, gum bichromate, ozotype, and Ostwald's catatype processes; and chapters on photographic measurements and the more exact testing of photographic plates, besides pages on sensitometry, actinometry, shutters, the illumination of the dark room, and many other subjects. In some cases where the subject dealt of is on the border line of what may be called pure photography, references are given to enable the student to continue his study of the matter if he should desire to do so. Although the book is essentially a student's book, it is also a practical guide, and those whose knowledge of chemistry and optics is slight will find at least a very appreciable help towards understanding the principles of their work as dealt with here in the few pages devoted to the exposition of the fundamental principles of these sciences as applied to photography. The general arrangement of the volume, with the significant headlines to the pages and copious index, facilitate reference to any desired subject. It is an invaluable book.

The Heart of a Continent.—The publication in a cheap edition of Colonel Younghusband's book, "The Heart of a Continent" (John Murray), comes at a most opportune moment. Not only because its author, as the hero of the Thibet Mission, has a special claim on the interest of the public just now, but because the travels described in "The Heart of a Continent" took place partly in the scene of the present Russo-Japanese War, as he visited Mukden and Kirin, and travelled through Manchuria. It would be difficult to have a more agreeable cicerone than Colonel Younghusband; his fine intelligence illumines all he touches, and the entire absence of prejudice with which he treats all he describes gives it a special value. We will quote as an instance the following comparison between the English and Russian Armies: "An English soldier is perfectly right when he has shaken down on active service, but in barracks he produces the impression that his dress is his main interest in life. A Cossack, on the other hand, whenever one meets him, looks as if he were ready to buckle to and fight then and there, and certainly dress or appearance is the last thing in the world he would trouble his head about."

A History of South America.—In his "History of South America" (John Murray), Mr. Charles Edmond Akers has admirably executed a most useful piece of work. Up till the appearance of this book, there was no general history of South America in existence; and the seeker after information had to glean his facts with pain and toil from writers of divers authority and nationality. Mr. Akers has provided in one moderate-sized volume a concise yet readable history of the South American Republics down to the present day. He has dealt in greatest detail with the events of the last fifty years, but the emancipation of Spain's Colonies is briefly described, and an introductory chapter relates the history of the Spanish Conquest. Subsequently Mr. Akers deals separately and at length with the histories of individual States. In a narrative that is of necessity so condensed there is not much scope for picturesqueness. The story is one of cruelty and oppression, bloodshed, and revolution, but it is told tersely and dispassionately, though Mr. Akers is a little too much inclined to judge medieval adventures by the standards of to-day. Here, for instance, is his estimate of the Spanish Colonists: "The national character had been formed under malignant influences, and the outcome was narrow-minded fanaticism, carelessness as to human life, despotic conduct towards all of lower rank, an absence of any impartial sense of justice. A lower standard of the relation of man to man, a narrower conception of public morality, it would, even in those days, have been difficult to find anywhere. It was from the scum of this fanatical population that the first Colonists came." Mr. Akers goes on to describe very briefly the ever-to-be-regretted destruction of Inca civilisation, one of the greatest tragedies of history. The chapters that follow are a remarkable achievement in their concise and well-proportioned marshalling of facts in which one dominant personality after another comes to the front and is conspicuous; and here great interest is added to the book by the portraits of leaders and presidents from Simon Bolivar onwards—men with strongly-marked features and rough exteriors. "Glancing back over the period which this history covers," says Mr. Akers, in conclusion, "there is everywhere the sense of human sacrifice, the all-pervading smell of bloodshed, no matter whether the country under review is Argentina, Brazil, Uruguay, or Paraguay. If these Republics would suppress their military establishments, and rid themselves of the armaments they have collected, tranquillity would be ensured. They are fond of posing as nations while still in their swaddling clothes. The possession of great stores of war material is a temptation to try conclusions with their neighbours." But even in this respect Mr. Akers thinks improvement is noticeable, and there is a growing desire for internal and external peace. What is necessary for the consolidation of peace is the "adequate administration

of justice throughout these Republics, protection for civil rights, and a more liberal system of education." No great ability, no extraordinary effort, no costly expenditure of money is necessary to achieve these results.

Across the Great St. Bernard.—Mr. A. R. Sennett is possessed of a facile and fluent eloquence, which he exercises with much effect in "Across the Great St. Bernard" (Bemrose and Sons). Alpine climbing is a subject which naturally affords scope for picturesqueness, and if the reader can overlook a too exuberant floweriness of style, he will find sincere enthusiasm, much interesting matter, and a genuine gift of observation on the part of his author. Mr. Sennett is a dauntless cyclist, and, wherever it was possible, his journey was performed by that means. Among many curious points of interest he raises is that of the curious physiological phenomenon, peculiar to high altitudes, known as mal-de-montagne. Its symptoms are described as follows: "Within an hour of the hospice I was seized with mal-de-montagne. . . My throat was dry, my head ached, as did my limbs; in the most unexpected manner I dropped in the snow, with an overpowering desire to sleep there and then." This form of seizure has been investigated by Professor Mosso, of Turin. He found that it generally began at a height of 12,000 or 13,000 feet. The symptoms are an extreme lassitude, with panting for breath, and sometimes vertigo, with nausea, and a tendency to syncope. Professor Mosso is of opinion that it is due not only to a deficiency of oxygen in the blood, but also to a lack of carbonic acid caused by diminution of air pressure, and he relieved a sufferer from mountain sickness by giving him carbonic acid gas to breathe, but M. de Thierry, on the other hand, states that carbonic acid gas exists in nearly the same proportion at a height of 12,000 feet as it does 6,000 feet lower. It is curious that Mr. Sennett was recommended by "the good father of the hospice at Simplon, if we felt faint, to eat the snow! Because," said he, "you may become faint for lack of oxygen, and mountain snow contains much air."

An Optical Dictionary.—"The Optical Dictionary" (Gutenberg Press), edited by Mr. Charles Hyatt-Woolf, is a useful glossary of optical and ophthalmological terms. It is intended for the use of students and others; and includes, in addition to strictly optical terms, a large number of words relating to photography and instruments of precision, as well as mathematical terms, and a certain number of French and German words in common use.

A German Grammar.—"Whitaker's Modern Method of Learning German" (Whitaker and Sons), by C. W. Whitaker and H. G. Braun, is intended primarily for the use of students who are teaching themselves. It contains much useful matter, a simplified grammar, examples of correspondence and conversation, exercises and translations. In our opinion the authors are mistaken in supposing that a student could obtain any idea how to pronounce the German language from the accompanying phonetic spelling in the reading lessons. What open-minded person, for instance, would imagine that "fair-gneá-goonks-rry-zer" represented the correct pronunciation of "Vergnügungsreise"? While the spelling Eesch for Ich and leesh for lich are surely unnecessarily misleading.

Trees.—The first volume on Buds and Twigs, Professor Marshall Ward's series on "Trees" (Cambridge University Press), is well calculated to fulfil the purpose for which it was intended—that of providing students of forest botany with a guide to the study of trees and shrubs from the point of view of the outdoor naturalist. The author seeks to rectify the existing neglect of the older methods of observation of the living plant, "which rendered the study of botany so exhilarating to the naturalist of pre-laboratory days." It is a most attractive little volume, filled with excellent illustrations. It is so far exempt from unnecessary technicalities as to make it suitable for the use of the amateur student of Nature, while at the same time it also includes an introduction to the study of systematic botany and morphology, and to what its author describes as "the expert study of forest botany."

The Story of the World.—A wise selection of an elementary text-book of history for Cape schools has been made by the Government in "The Story of the World" (Wm. Blackwood), by Miss M. B. Synge. It is published in five volumes, each one complete in itself. The first, which is in some ways the best of the series, tells the story of the world up to the time of Julius Cæsar. The method adopted has been to deal only with well-known events and incidents likely to impress themselves readily on a child's mind; these are described in a pleasant, popular style, and briefly connected by a historical narrative. The illustrations are attractive and instructive. The four successive volumes deal with the periods from the Roman Empire to the Renaissance (Vol. II.); from the Reformation to the Seven Years' War (Vol. III.); and from the American War to Waterloo, "The Struggle for Sea Power" (Vol. IV.). A volume on "The Growth of the British Empire" (Vol. V.), covering the period from Waterloo to 1903, completes the series.

Photography.—"How to Photograph with Roll-Cut Films" (Hazell, Watson, and Viney, Limited), by John A. Hodges, F.R.P.S. A good manual for the amateur; should be very popular. Price 1s. net.

A New Catechism (Watts and Co.), by Mr. M. M. Mangasarian Lecturer of Independent Religious Society of Chicago, is an attempt to give, in question and answer form, a popular commentary upon current beliefs, phenomena, and institutions. It deals with such subjects as Reason and Revelation, the Church Creeds and Clergy, Death and Immortality. It appears to be a sincere attempt to face the essential facts of life.

Key to Godfrey and Siddons' Geometry.—Mr. E. A. Price has done a useful piece of work in preparing a "Key to Godfrey and Siddons' Geometry" (C. J. Clay and Sons, Cambridge University Press Warehouse). A key is essential to a work of this kind, and will treble the usefulness of an excellent Textbook of Geometry for Preparatory Schools.

Philosophy of Herbert Spencer.—Mr. W. H. Hudson has revised and partly rewritten his "Introduction to the Philosophy of Herbert Spencer" (Watts and Co.), which now appears in a cheap and popular edition. It is intended as a guide to the study of the Synthetic System, rather than a summary of it; it also includes a biographical chapter. It is written in as clear and popular a style as is consistent with the subject.

Second-Hand Books.—From Messrs. John Wheldon and Co. we have received a copy of their newly-issued list of miscellaneous books, in which, we notice, the various branches of science are well represented.

Physical Apparatus.—Messrs. F. E. Becker and Co. (W. & J. George, Limited, Successors) have sent us a copy of their new list of apparatus in the various departments of Physics, including Sound, Light, Heat, Magnetism, Electricity, Mechanics, &c. This exhaustive catalogue consists of over 600 pages and some 4000 illustrations. One of its noteworthy features is that the requirements of science teaching in this country and its Colonies are always kept in view, and the articles listed cover the latest developments in their subjects. The method adopted in the list itself, together with the completeness of the index, is such as to make reference to it simple and expeditious.

Brooks' Flexible Curves.—Mr. W. J. Brooks, of Fitzroy Street, sends for our inspection the devices which he has patented for assisting draughtsmen to draw experimental curves. These devices are three in number—a flexible strip of celluloid or steel provided along its length with tabs which can be held down by the fingers, a steel strip to which any shape can be given by means of a stiff-hinged linkwark that is attached to the tabs and holds them permanently in position, and an elaboration of a similar principle suited for drawing long curves. In this third pattern light wooden cross-bars hinged to the tabs slide through brass spring-clamps, and are thereby held friction-tight against a long wooden bar running like an abscissa of the curve. These devices, together with one or two modifications and accessories of them, are as practical as they are ingenious, and will be found of great service to architects, designers, engineers, or experimenters in mathematical physics and to draughtsmen generally.

MICROSCOPY

Conducted by F. SHILLINGTON SCALES, F.R.M.S.

Coccidae.

With Notes on Collecting and Preserving.

By ALICE L. EMBLETON, B.Sc.

(*Continued from page* 251.)

FROM this brief sketch of some of the points in the life-history of *Comys infelix*, it can be gathered that very special microscopic methods are required to do such a piece of work on Coccid parasites. It has been found that the eggs can be sectionised while still in the abdomen of the fly. The best fixing reagent has been found to be Gilson's fluid (the formula for which will be found in a footnote), used cold. The specimens

Formula for Gilson's Fluid :—

Nitric Acid, 46° ..	..	..	19·5 cc.
Glacial Acetic Acid	..	..	5·5 cc.
Corrosive Sublimate	..	..	23·75 cc.
Alcohol, 60 per cent.	..	..	125 cc.
Distilled Water ..	..	..	1100 cc.

were left in nearly half-an-hour, then washed very thoroughly in 70 per cent. alcohol, and so gradually taken to absolute alcohol, cleared in cedar wood oil, and fixed in paraffin (not too hard—certainly not more than 52 degrees melting point). The sections give best results for nuclei of eggs when stained by the iron-alum-hæmatoxylin method, with eosin as the second stain ; the nuclei in such preparations show their structure very clearly, and the mounts are permanent. The youngest little white larvæ are best seen in water or dilute glycerine, the tracheæ, then remaining full of air, show up dark and well-defined. For some structural points it is well to treat them with very weak osmic acid, or, better still, expose them for a minute or two to the fumes of osmic acid over the mouth of a bottle containing it. It is inadvisable to use alcohol with these larvæ, as they shrink, and very little can be ascertained from such specimens. Some aqueous stains take well on these larvæ, but on the whole those mounted in water or dilute glycerine, unstained, seem the most satisfactory, though they have the disadvantage of not being permanent.

The crystal-containing envelopes are best seen by polarised light. The microchemical tests to prove these crystals to be uric acid also need special care and methods. Many of the other points in such an investigation as this must be confirmed by means of serial sections, to prepare which it has been found best to fix the specimens in Gilson's fluid, the nitric acid of which serves to soften the chitine. Various stains may be used, but to see nuclei the iron-hæmatoxylin and eosin will be found to be as good as any—or with Grubler's orange G instead of eosin.

The above gives an inadequate account of the methods of investigating some of the finer points in the developing and life-history of a Coccid parasite, but, perhaps, it would not be out of place here to give some general directions for collecting and preserving *Coccidae* themselves. Such directions have been given over and over again by entomologists of all countries for the collecting and preserving of *Coleoptera*, *Lepidoptera*, etc., but *Coccidae* are not, and never have been, favourite insects for the collector, and so it may not be superfluous to give here some notes as to the best methods to be employed for collecting and preserving these interesting but much-neglected creatures. They differ so widely from other insects that special methods are necessary. There is a great field for the collector in Coccidology, as collections have been made from very few parts of the world, for, whereas very representative collections exist of other insects from North and South America, most European countries, Africa, New Zealand, and India, yet the *Coccidae* are practically unknown. The collections that do exist are at best very local and very incomplete. This is all the more extraordinary when one remembers how destructive *Coccidae* are, especially in tropical countries, where they are conspicuous on almost every plant. This neglect has not come about because these creatures are in any way specially difficult to deal with, for they are remarkably easily collected, and immense numbers can be packed in very small space, and sent through the post without harm befalling them.

As regards localities, though *Coccidae* are found north and south of the fortieth parallels, yet they cannot be looked upon as abundant. Search for them will be best rewarded in the warmer temperate zones, and in the tropics, where there is a vast unworked field of investigation that would richly reward the entomologist. They are found chiefly on trees and shrubs, ferns and palms ; much collecting may be done by those who receive plants from the tropics, and importers have great opportunities not only for collecting these insects, but also for preventing the introduction of harmful species.

In collecting it is best to simply gather portions of the host plant without disturbing the parasites, and to get plenty of the material, and both sexes where possible. In preserving it is well to avoid alcohol, for specimens collected in this way are often useless and cannot even be identified ; however, it is sometimes useful for the softer species, but, as much as possible, *Coccidae* should be preserved dry. Flat card boxes serve the purpose best, though envelopes are useful ; yet boxes have the advantage of saving any parasites that may emerge ; a full description of locality, date, etc., should be written on each. Tin boxes being air-tight give rise to mould, and should therefore be avoided. With those specimens which are too fragile to preserve well, a rough sketch of their form should be made. To keep permanently, place the *Coccidae* in glass tubes, with cotton wool stoppers until the specimens are quite dry, and then later put in india-rubber stoppers.

To mount for the microscope, it is first necessary to boil away all the soft parts with caustic potash, and then mount in Canada Balsam, after the usual washing dehydrating, and clearing procedure.

A Means of Marking the Position of Objects upon the Cover-Glass.

It is often necessary to mark upon the upper surface of the cover-glass the position of objects mounted beneath it, but it is by no means easy to do so without

some mechanical aid. I have found that the simplest, and perhaps easiest, method is to carefully bore and file out a sound cork, or portion of a cork, so as to fit not too tightly over the end of the objective, leaving a fairly substantial margin to give comparative rigidity. Through this margin is bored a small hole pointing downwards and inwards towards the optical axis, and holding a fine sable-brush. The marking liquid may be Brunswick black, or asphalte thinned to a suitable consistency with turpentine. It is then only necessary to adjust the brush up or down in its obliquely-placed hole so as to give a ring of the requisite size, to rack the objective down towards the cover-glass until the brush is in contact with it, and to rotate the cork ring which holds the brush so as to describe the necessary circle. The rotation should be in the opposite direction to the hands of a clock so as to avoid unscrewing the objective on the one hand, or unscrewing the front lens on the other, and for the same reason this direction of rotation should be adhered to in putting the cork on to the objective or in taking it off. Too much black must be avoided, and the brush must be very carefully pointed, or the ring is not made neatly and satisfactorily. Another method is to fit a cork on to the objective in the same way but to allow it to project somewhat, and to press into it a small brass ring with a carefully ground edge. This ring is painted with the marking fluid and brought down gently upon the cover-glass, but it is difficult to make neat rings by this means, and to be of much use the brass ring and the consequent hole in the end of the cork have to be much smaller than the bore which takes the objective, so that the cork is not easy to file out, and the projecting ring interferes with the field of the objective with low powers, and with the focussing with high ones.

Glare when using a Vertical Illuminator

Workers on metal specimens who use the vertical illuminator are aware of the glare which is constantly present in the field of view, and often to such an obtrusive extent as to seriously diminish sharpness of definition and perception of detail. This is generally due to reflections from the inside of the mount of the objective. This glare may be greatly reduced—in fact, for practical purposes, eliminated, by placing an Iris diaphragm close to the source of light and reducing the aperture through which the light passes, by means of this diaphragm, to such a point as will remove the objectionable glare. It will be found that this will not affect the brilliance of the actual image, for only precisely the amount of light that can be usefully utilized, no less and no more, will pass through the objective. A similar arrangement in connection with ordinary photo-micrography removes the glare which is so often objected to, from the inside of the body of the microscope.

Notes and Queries.

J. M. Dunbar, East Griqualand.

Several correspondents kindly answer my query last month by recommending Hassall's "Adulterations Detected" (Longmans, 1857) as a book which deals with the microscopical examination of adulterated foods. It contains over 200 microscopical illustrations. I am also referred to Battershall's "Food Adulteration," price 15s., which has photo-micrographic plates, This last is an American publication, but may be had in London at Spon's.

J. Carrington, East London, S.A.

I would recommend you to get Lewis Wright's "Popular Handbook to the Microscope" (1895), published by the Religious Tract Society at 2s. 6d. This is quite elementary, and contains chapters on some common microscopical objects. Also Cross and Cole's "Modern Microscopy" (1903), published by Baillière, Tindall, and Cox, at 4s. This deals most clearly with the microscope and its use on the one hand, and with mounting methods on the other. If you have any special difficulty I shall be glad to help you with it.

J. P. Hodges, Grangetown, Yorks.

The resolution of *Amphipleura pellucida* has long been a favourite task with amateurs, but it is really not so difficult as it seems. The first requisite is to have the diatoms mounted in a medium of suitable refractive index, such as realgar, though monobromide of naphthalin will do. The objective should have an aperture of about 1·25 or more, and if the condenser is also an immersion one the result will be the more satisfactory. Search the slide and pick out a good diatom—they vary more than would be imagined. Carefully centre the condenser with a low power by means of the iris diaphragm, then bring the lamp-flame into the centre of the field, using the edge of the flame and keeping the tail-rod central. Focus the flame sharply with the condenser. Now change the objective to the $\frac{1}{12}$th, and without altering mirror or lamp recentre the flame and refocus it. The transverse striations should now be seen pretty clearly, and will not be improved by closing the diaphragm. But if not successful proceed as follows: See that the lamp is exactly opposite the microscope, and the mirror adjusted so that the lamp-flame lies vertically in the centre of the field. Adjust the slide so that the diatom also has its long axis vertically in the centre of the field. Make all other adjustments as before, taking pains with the centring. Now beneath the condenser put a stop which has one slit in it reaching from the edge to the centre, and about $\frac{1}{8}$ inch wide, placing the stop so that the slit lies to the front of the condenser. A slight tilt of the mirror in its gymbals may be necessary to bring the striations clearly into view, and a little adjustment within narrow limits sometimes works wonders, but the principle is to throw a narrow and very oblique beam of light longitudinally down the diatom. Of course the image does not represent the real structure of the diatom, and that is a point which has been much discussed. The resolution of diatoms is certainly not a waste of time; I question if anything so soon teaches a microscopist how to use his instrument to best advantage, or if any other study has given as much impetus to the demand for better objectives, better corrections, and better apertures, and so helped to bring about the comparatively recent great advance in this respect.

Microscopical Material.

Mr. Alfred Death, of Bury St. Edmunds, has kindly sent me for distribution a quantity of Echinus spines. The cutting and rubbing them down for mounting is, as Mr. Death says, somewhat tedious work, but they make beautiful objects for either directly transmitted light or annular illumination, generally known as "dark-ground." Mr. Death gives the following *résumé* of his method of procedure: (1) Make transverse section, as of any hard tissue. (2) Rub one side quite smooth upon a hone, preferably Water-of-Ayr stone. (3) Fasten smooth side upon glass slip with Canada balsam. (4) Grind section on glass upon hone until sufficiently thin. (5) Remove section from hone by warming over spirit lamp. (6) Pass through alcohol into clove oil and mount in Canada balsam. I shall be pleased to send one or two of these spicules to any reader who sends me a stamped addressed envelope, together with the coupon appearing in another part of this issue, and it will be a convenience to me if applicants will enclose in the envelope a small piece of tissue paper in which to fold the minute spicule.

[*Communications and enquiries on Microscopical matters are invited, and should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road, Cambridge.*]

XUM

The Face of the Sky for November.

By W. Shackleton, F.R.A.S.

The Sun.—On the 1st the Sun rises at 6.55, and sets at 4.32; on the 30th he rises at 7.44, and sets at 3.53. The equation of time is a maximum on the 3rd, the Sun being 16m. 21s. before the clock.

Sunspots and prominences have been numerous of late; at the time of writing five groups of spots are visible.

The positions of the spots, &c., with respect to the equator and poles may be derived by employing the following table :—

Date.	Axis inclined from N. point.	Centre of disc, N of Sun's equator.
Nov. 1 ..	24° 39′ E.	4° 11′
,, 11 ..	22° 33′ E.	3° 6′
,, 21 ..	19° 41′ E.	1° 54′
Dec. 1 ..	16° 6′ E.	0° 38′

The Moon :—

Date.	Phases.	H. M.
Nov. 7 ..	● New Moon	3 37 p.m.
,, 15 ..	☽ First Quarter	0 36 a.m.
,, 23 ..	○ Full Moon	3 12 a.m.
,, 30 ..	☾ Last Quarter	7 38 a.m.

The Planets.—Mercury is in superior conjunction with the Sun at the beginning of the month, and towards the end of the month he becomes an evening star, setting about an hour after the Sun.

Venus is an evening star setting about 5.45 p.m. on the 1st, and about 6.15 p.m. on the 30th. Towards the end of the month the planet will be observable after sunset, but low down in the S.W. The disc is gibbous, and has an apparent diameter of 13″·0.

Mars is a morning star situated on the confines of Leo and Virgo, rising at 2 a.m. on the 15th.

Jupiter is in an extremely favourable position for observation, and is the most conspicuous object in the evening sky looking S.E., being visible from sunset until early morning.

The equatorial diameter of the planet on the 1st is 50″·0, whilst the polar diameter is 3″·2 smaller.

At 11 p.m. on the 19th the planet is in proximity to the Moon, being only 1°½ to the North.

The configurations of the satellites, as seen in an inverting telescope at 10 p.m., are as follows :—

Day.	West.	East.	Day.	West.	East.
1		21○43	16		2○134
2		2○413	17		13○24
3		431○2	18		3○124
4		43⊙2	19		3241○
5		432○1	20		432⊙
6		413○2	21		4○132
7		4○123	22		412○3
8		4½○3	23		42○13
9		42○13	24		413○2
10		3¼○2	25		43○12
11		3○¾4	26		3421○
12	●	32○4	27		324⊙
13	●	⅛○4	28		○1324
14		○1234	29		1⊙34
15		12○34	30		2○134

The circle (○) represents Jupiter; ⊙ signifies that the satellite is on the disc; ● signifies that the satellite is behind the disc, or in the shadow. The numbers are the numbers of the satellites.

Saturn is on the meridian about 1½ hours after sunset; hence this is the best time for making observations; the brightness of the planet is diminishing in consequence of increasing distance from the earth.

The ring appears widely open and we are looking down on the northern surface at an angle of 16°; on the 5th the polar diameter of the ball is 15″·6, whilst the major and minor axes of the outer ring are 39″·4 and 11″·0 respectively.

The planet is in quadrature with the Sun on the 7th.

The moon is near the planet on the evening of the 14th.

Uranus is unobservable, setting shortly after sunset.

Neptune rises about 11 p.m. near the middle of the month; his position in the constellation Gemini will be seen on reference to the chart appearing in the January number.

Meteors :—

The principal showers of meteors during the month are the Leonids and Andromedids. Watch should be kept for Leonids after midnight of the 14th and 15th, when the moon will have set.

Date.	Radiant. R.A.	Radiant. Dec.	Characteristics.
Nov. 14–16	150°	+ 22°	Swift, streaks. (Great Leonid shower.)
Nov. 17–23	25°	+ 43°	Very slow; trains. (Great Adromedid shower.)

Encke's Comet :—

The re-discovery of Encke's comet by photography with 3½ hours exposure at the Königstuhl Observatory has been confirmed by a later photograph taken at the same place, which establishes its identity beyond doubt. The comet is described as extremely faint and diffuse. Its approximate position on November 1 is R.A. 23 hr. 17 m., Dec. + 26° 51′, or a little east of β Pegasi; it is moving in a direction W. by S.

The Stars :—

About 9 p.m., at the middle of the month, the following constellations may be observed :—

Zenith . Cassiopeia.
South . Andromeda, Pisces Cetus; Pegasus, Aquarius towards S.W.
West . Aquila, Cygnus, Lyra a little north of west, Corona N.W. setting.
East . Auriga, Perseus, Pleiades, Taurus; Aries to the S.E.; Orion rising S.E.
North . Ursa Major, Ursa Minor, Cepheus; Draco a little west of north.

Minima of Algol will occur on the 8th at 11.50 p.m., on the 11th at 8.39 p.m., and on the 14th at 5.28 p.m.

Telescopic Objects :—

Double Stars :—η Cassiopeiæ $0^h\ 43^m$, N. 57° 17′, mags. 3½, 7½; separation 5″·7. Binary star.

λ Arietis $1^h\ 52^m$, N. 23°·6′, mags. 4, 8; separation 37″. Components white and blue; easy with power 20.

η Persei $2^h\ 44^m$, N. 55°·28′; mags. 4, 8; separation 28″. The brighter component is orange, the other blue. There are also several other fainter stars very near.